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Index To Volume 114
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INDEX, 1940

VOLUME, 114

A

Accelerometers, Gray, Miner and Symington 349*
Accidents
  Bureau of Locomotive Inspection report 52*
  City of San Francisco (Sou. Pac.)..13, 21§
  Grade crossing and trespassing..... 515†
  Pioneer Zephyr (C. B. & Q.).....107, 110§
  Water in cylinders, Damaging effects of, by M. D. Franey ..... 361‡
Acker, S. H., Equalizing flow of air through locomotive grates 140*
Advertising, Stenciled, on freight cars (A. T. & S. F.) 363*
AGA Metal Tube Co., Tubing of carbon and alloy steel 205*
Age, Average, of railroad workers in 1938.. 333†
Air brakes (see Brakes, Air)
Air conditioning—Asset or liability?..... 315§
Air Reduction Sales Co., Planograph gas cutter 113*
Alan Wood Steel Co., Slotted running boards 314*
Alarm, Low-water, with two whistles, Barco Mfg. Co. 7*
Allied Ry. Supply Assn.
  Election of officers 509
  Exhibit 394
  Exhibitors 357, 509
Allis-Chalmers Mfg. Co., Turbine and condensing locomotives research work (R. F. & T. E. A.) 503
Aluminum Co. of America, 3,000,000-lb. testing machine 124
American Car and Foundry Co., Berwick centennial ..... 241†
American Locomotive Co., 660- and 1,000-hp. Diesel switchers..... 379*
American Optical Co., Respirator filter cartridge 422*
American Rolling Mill Co., George M. Verity, honored 334
American Society of Mechanical Engineers
  Botteron, L. K., Locomotive cylinder-power measurement 526
  Brandt, C. A., The locomotive boiler 43*, 66§, 100*
  Fry, L. H., Chairman Railroad Div..... 37
  Officers for 1941 516
  Ryan, J. L., Combating locomotive obsolescence 310*
American Steel Foundries, Truck-spring snubbers, by W. S. Spieth 175*
American Wood Preservers' Assn., Treated wood for car lumber ..... 358§
Anderson, H., Heater cars for use with Diesel-electric locomotives 186*
Apprentices, Lehigh Valley, honored..... 557†
Arbitration Committee Decisions
  Case No.
    1770—Southern vs. Pennsylvania-Conley Tank Line—Rules 12 and 84..... 35
    1771—Missouri Pacific vs. Texas & New Orleans—Rules 32 and 44..... 35
    1772—Mobile & Ohio vs. St. L.-S.F.—Rule 5..... 236
    1773—St. L.-S. F. vs. T. P. & W.—Rule 84 236
    1774—St. L.-S. F. vs. Missouri & Arkansas—Rule 12 366
    1775—Pennsylvania-Conley Tank Line—Rule 113 366
    1776—St. L.-S. F. vs. S. A. L.—Rule 12 366
    1777—Philadelphia Quartz Co. vs. N. Y. N. H. & H.—Rules 32 and 43..... 406
    1778—C. G. W. vs. Missouri Pacific—Rule 43 406
Arbitration Committee report (Mech. Div.).. 265
Armour Institute of Technology, Summer graduate institute 170*
Army maneuvers make heavy demands on railroads ..... 374†
Aronson, Jacob, Monopoly mind in employee relations .....542§, 555†
Ash pan hopper castings 370
Association of American Railroads
  Car Service Division
    Military Transportation Section..... 332†
    Report ..... 557†
  Mechanical Division
    Addresses
      Buford, C. H. 247
      Hall, J. M. 249
      Hankins, F. W. 248
      Patterson, W. J. 249
Association of American Railroads—(*Continued*)
  Mechanical Division—(*Continued*)
    Annual meeting .....245*, 287§
    Arch-bar truck rule modifications..... 82
    Diesel-electric cost study ..... 359§
    Election of officers 247
    Gray, W. G., assistant mechanical engineer 298*
    Reports
      Arbitration Committee 265
      Axle, Passenger-car 283
      Brakes and brake equipment..... 254
      Car construction 277
      Couplers and draft gears 255
      General Committee 246
      Intercrystalline cracks in locomotive boilers, by W. C. Schroeder, A. A. Berk, and R. A. O'Brien 262*
      Labor and material prices 260
      Loading rules 261
      Locomotive construction 271*
      Lubrication of cars and locomotives.. 250
      Specifications for materials 270
      Tank cars 259
      Wheels 251
    Tests
      Draft-gear recoil 258*
      Truck, Freight-car 345*
  Open meeting .....542§, 555†, 557†
Pelley, J. J.
  1940 outlook 39
  Readiness and capacity of railroads.... 517
Purchases and Stores Division—Subject committees 556
Atchison, Topeka & Santa Fe
  Advertising, Stenciled, on freight cars.. 363*
  Cars, Pendulum type ..... 126†
  Crane, P. & H. Model 255 crawler.... 554*
  Foreman, Road, and Diesel-electric locomotive, by Leo W. Powell..... 505
  Locomotive, Diesel-electric, Design, operation and maintenance of, by H. V. Gill 131*, 202, 409, 437*
Atlantic Coast Line, Igloo, sand-drying house, by C. L. Meister 544*
Axles, Passenger-car, Progress report (Mech. Div.) 282
Ayers, A. R., How to increase freight-train speeds ..... 226§

B

Balancing machines, Dynetric, Gisholt Machine Co. 158*
Baldwin Locomotive Works
  Dispensary at Eddystone ..... 298†
  Locomotives, Stock ..... 37†
  Switchers, Diesel-electric, 1,000 and 660-hp. 56*
  Test: Furnace and firebox support and boiler waste sheets (Mech. Div.).... 271
Baltimore & Ohio, Diesel-electric completes 365th daily run ..... 169†
Barco Mfg. Co.
  Alarm, Low-water, with two whistles.. 7*
  Connections
    Locomotive-tender, Type 3VX..... 189*
    Steam-heat, FT-2 ..... 413*
Bearing, Roller, applications in United States and Canada (Mech. Div.) 273
Beaver Pipe Tools, Inc., Model C threading machine 423*
Becket, Frederick Mark, Dr., Elliott Cresson Medal 242
Bell, Spurgeon, Productivity, Wages and National Income..... 190§
Bending press, Model J-12, Cleveland Crane & Engineering Co. 421*
Bentley, Frank, Spring cotter for lifting scale 371*
Berk, A. A., Intercrystalline cracks in boilers (Mech. Div.) 262*
Berkley Machine Works & Foundry Co., Stoker 414*
Bethlehem Steel Co., Red Tiger tool steel.. 236*
Billing, Interchange and (C. D. O. A.).... 485
Birch, T. H., Pipe and air-brake shop devices (C. M. St. P. & P.) 550*
Black & Decker Mfg. Co., No. 8 Tapgun.. 419*
Blowdown, Boiler, methods and control (M. B. A.) 462
Blow-off system, Automatic, Electomatic.... 26*
Blow-off valves, Okadee Co. 286*
Boiler, Locomotive
  Capacity of, Determining, by Edward J. Harley ..... 362‡
  Cracks, Intercrystalline, in (Mech. Div.) 262*
  Embrittlement in boilers, by W. C. Schroeder (M. B. A.) 182*
  Explosions
    Due to low water .....66§, 238‡
    In Germany, by Wm. T. Hoecker.... 362‡
  Fabricating, with micrometers ..... 541§
  Maintenance, Problems of, by A. G. Trumbull 451
  Materials and construction (Mech. Div.) 276
  Patches (competition)...26*, 79*, 200*, 232*, 370*
  Questions and Answers
    Dry pipe, Design of, in boilers without steam dome 233
    Evaporation, Determining, size of injector and safety valves.....330, 362‡
    Firebox sheets, Holding and welding.. 373
    Gage, Steam, Testing and repairing.. 163
    Gusset brace, Cross-sectional area of, Determining 372*
    Patches, Crown-sheet, Types of..... 411*
    Pressure reduction, alteration report required in 549
    Rivet holes, Checked and cracked, in door sheet 164*
    Rivets required to hold brace rods.. 164
    Shell course tolerances 373
    Shell, Reinforcing a circumferential groove in a 204*
    Shells, Defective, Reinforcement of, by E. H. Heidel 200*
    Staybolts, Calculating area supported by 25
    Staybolts, Unequally-spaced, Area supported by 372*
    Stoker tubes, Design and application of 164*
    Syphon patch with a spiral seam.... 79*
    Tube sheet, Front, Application of, by welding 204*
    Tubes, Renewing, in a Coffin feedwater heater 26*
    Wrapper sheets, Grooved and corroded, Repairing 545
  Reproportioning (I. C.)..... 310
  Steel, Nickel, for (M. B. A.) 463
  Study of, by C. A. Brandt (A. S. M. E.) .....43*, 66§, 100*
  Welded (D. & H.) 274, 457
Boiler maker, The master—His accomplishments and opportunities, by M. A. Quinn (M. B. A.) 451
Boilermaking with micrometers ..... 541§
Boiler Makers' Assn.
  Address by
    Elliott, Edward C., Neglected high pressures 452
    Henry, Robert S., Two jobs for every railroad man 536
    Quinn, M. A., Accomplishments and opportunities of the master boiler maker 451
    Trumbull, A. G., Problems of boiler maintenance 451
  Election of officers 450
  Meeting 354, 391, 393, 450
  Reports and papers
    Boilers, Embrittlement in, by W. C. Schroeder 182*
    Boilers, Fabricating ..... 541§
    Cinder cutting of firebox sheets, flues, tubes and smokeboxes 469
    Feedwater, Boiler, Chemical treatment of 462
    Firebox materials, Service of, McBrian, Ray 531*
    Rivets, Iron, Steel and alloy, application of 463
    Tender cistern maintenance 471
    Tube and flue application 468
    Water circulation in the boiler, Means to improve 459*
    Welding — Oxyacetylene and electric processes in boiler and tender work 453
Boilers, Stationary, Coal-fired (R. F. & T. E. A.) 503
Books
  A. S. T. M. Specifications for Pipe and Piping Materials 67
  Dictionary of Metals and Their Alloys, F. J. Camm 289
  Diesel Engineering Handbook 111

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Books—(*Continued*)
Diesel Engines, by B. J. von Bongart.. 23
Engineering Opportunities 23
Machine Shop Training Course, by Franklin D. Jones 401
Procedure Handbook of Arc Welding Design and Practice 317
Proceedings
Association of American Railroads, Mech. Div. 289
Car Dept. Officers' Assn., 1939..... 227
Master Boiler Makers' Assn..... 67
Railway Fuel and Traveling Engineers' Assn. 111
Productivity, Wages and National Income, by Spurgeon Bell ..... 190§
Smoke Prevention 360
Tool Making, by Charles Bradford Cole 152
Turret Lathe Operator's Manual..... 317
Who's Who in Railroading in North America 360
Wrought Iron, Its Manufacture, Characteristics and Application, by James Aston and Edward B. Story 67
Boring machines (see Machine Tools)
Botteron, L. K., Cylinder power measurement (A. S. M. E.) 526
Box, Driving, work at Pen Argyl (L. & N. E.) 407*
Box, Journal
Hot (C. D. O. A.) 480
Temperature, by E. S. Pearce..67§, 69* 238‡
Brake, Air
D-22 passenger control valve
Questions and answers on..33, 73, 121, 156, 198, 322, 367, 406, 553
Report (R. F. & T. E. A.)..... 496
Locomotive, No. 8-ET (R. F. & T. E. A.) 494*
Maintenance, by J. P. Stewart (L. M. O. A.) 440
Shop devices (C. M. St. P. & P.)..... 550*
Sticking (C. D. O. A.)..... 481
Brake-beam failures (C. D. O. A.)..... 481
Brake, Hand, Ajax, on Western Maryland flat cars 181*
Brake-rigging failures, Winter weather and 150§
Braking, High-speed, Developments (R. F. & T. E. A.) 494*
Brakes and brake equipment (Mech. Div.).. 254
Brakes, Freight-car, and weight reduction, by V. R. Willoughby 223
Brandt, C. A., The locomotive boiler..43*, 66§ 100*
Brass, Journal, trimmer (Ill. Cen.) 32*
Brookings Institution, "Productivity, Wages and National Income" ..... 190§
Bryan, J. E., Shippers proud of railroads... 555†
Bucking bar for steel car work..... 322*
Buda Co., Two-speed journal jack 416*
Budd disc brake (R. F. & T. E. A.)..... 497
Budd, Edward G., Mfg. Co., Analysis of Florida streamliner business..... 557
Budd, Ralph, Adequacy of transportation... 515†
Buford, C. H., Address (Mech. Div.)..... 247
Bulldozers for forming steel car parts (C. B. & Q.) 234*
Bureau of Locomotive Inspection (see Inter-State Commerce Commission)
Bureau of Safety (see Interstate Commerce Commission)
Bushings, Link trunnion, Applying, by A. D. Hollis 78*
Bushing, Staybolt-hole, Lewis Bolt & Nut Co. 415*
Bushings, Rod, Slotting, on a bushing..... 202*

C

Canadian National
Cars, Refrigerator, with overhead icing 211*
Lagging, Block, Method of applying.... 161*
Locomotives, 4-8-4 (Montreal)....171†, 187*
Sash cleaning and glazing at Pt. St. Charles 197*
Springs, Carbon-steel, Reconditioning... 201*
Car
Freight
Construction (Mech. Div.) 277
Design: Car foreman know details.... 110§
Maintenance (C. D. O. A.)..... 480
Maintenance, performance and expense, by O. A. Garber (C. D. O. A.) 474
New, Number of, put in service first half of 1940 ..... 333†
Orders May 1, 1939, to May 1, 1940 (Mech. Div.) 278
Reconditioning ..... 541§
Weight reduction, by V. R. Willoughby 223
Passenger, modernization ..... 22§
Roof (see Roof)
Underframes (see Underframes)
Carboloy Co., Cutting tools standardized.... 420*
Carboloy tools on machining work (G. T. W.) 368*
Car department, Importance of, in rail transportation, by J. M. Symes (C. D. O. A.) 473
Car Dept. Officers' Assn.
Election of officers 473
Address by
Garber, O. A., Car maintenance, performance and expense 474
Car Dept. Officers' Assn.—(*Continued*)
Address by—(*Continued*)
Henry, Robert S., Two jobs for every railroad man .....511§, 536
Symes, J. M., Importance of car department in rail transportation 473
Meeting 353, 472*
Reports
Commodity cards, Standard classification 478
Freight-car maintenance 480
Interchange and billing 485
Loading rules 484
Lubricants and lubrication 477
Painting 483
Shop operation—Electric welding 475
Supplements A. A. R. Mechanical Division ..... 514§
Work of, commended ..... 514§
Cars
Freight
Box
Automobile, D. & R. G. W. (Pressed Steel) 62*
50-ton, all-welded, (C. M. St. P. & P.) 528*
Caboose
Model, J. M. Fesco 170*
With side-observation bay windows (C. M. St. P. & P.) 193*
Flat, All-welded (Western Md.-Greenville) 181*
Hopper
Cor-Ten, show low weight loss..... 149
Nor. Pac. (ACF) 137*
Rebuilt, for cement (Lehigh Valley). 318*
Welded (Mech. Div.) 278
Refrigerator, with overhead icing (Can. Nat'l) 211*
Stock, Idea of, by D. V. Costello..... 157
Tank car report (Mech. Div.) 259
Passenger (see also Trains, High-speed)
Chair, Rebuilt (Mo. Pac.) 118*
Coach, Cor-Ten steel, Pressed Steel Car Co. 382*
Coach-sleeper, Triple-deck (Pullman Co.) 241*
Coaches, Lightweight (D. & H.)..... 8*
Pendulum type ..... 126†
Rail car, Air-cooled (N. Y. S. & W.)... 303*
Cars, Heater, for use with Diesel-electric locomotives (Ill. Cen.) 186*
Carnegie-Illinois Steel Corp., USS Cor-Ten vs. copper steel 60*
Carter, Charles F., dies 39
Castings, Ash-pan hopper 370
Champion Rivet Co., Rivets and riveting (M. B. A.) 465*
Chapman, E. E., Steam consumption of locomotive auxiliaries (R. F. & T. E. A.).... 492
Chicago & North Western
Flies, Combating 402*
"400" locomotives complete 300,000 miles ..... 333†
Chicago, Burlington & Quincy
Car parts, Steel, Forming..... 234*
Cars, Pendulum type ..... 126†
Enginehouse problems, by H. E. Hinds (L. M. O. A.) 446
Fuel—Percentage than can be saved, (R. F. & T. E. A.) 489
Pioneer Zephyr wreck .....107, 110§
Tractor with side-dump trailer 367*
Train, 17-car stainless-steel ..... 296†
Chicago, Milwaukee, St. Paul & Pacific
Cabooses with side observation bay windows 193*
Cars, Box, 50-ton all-welded 528*
Forgings, Locomotive, Quenched and tempered, by L. E. Grant and J. W. Crossett 219*
Locomotives, 4-8-4 type 216*
Pipe and air-brake shop devices, by T. H. Birch 550*
Chicago, Rock Island & Pacific
Medallion 75*
Rod, Piston, design, Safety features in 24*
Cincinnati Electrical Tool Co., Air Master dust-collector unit 157*
Cincinnati Milling Machine Co., Hydro-Tel milling machine 419*
Cinder cutting of firebox sheets, flues, tubes and smokeboxes (M. B. A.) 469
City of San Francisco wreck (Sou. Pac.).13, 21§
Clean-out tool for water columns, by Arthur Havens 371*
Cleaning devices
Locomotive and car, Thermo-pressure, Vapor Car Heating Co. 331*
Tank-car unit, Oakite Products, Inc... 364*
Cleaning, Mechanical, of fine coal (R. F. & T. E. A.) 500
Cleveland Crane & Engineering Co., Model J-12 Steelweld bending press 421*
Clubs and Associations
Car Dept. Assn. of St. Louis
Speeds, Freight-train, Increasing, by A. W. Ayer ..... 226§
Stock car idea, by D. V. Costello.... 157*
Car Foremen's Assn. of Chicago
Braking trains under modern conditions, by L. K. Sillcox 240
Election of officers 516
Eastern Car Foremen's Assn. outing.. 334
Clubs and Associations—(*Continued*)
Northwest Carmen's Assn., Truck-spring snubbers, by W. S. Spieth..... 175*
Pacific Railway Club, Diesel switcher savings, by M. D. Raymond 81
Coal (see Fuel)
Collective bargaining ..... 515†
Collins, W. E., Locomotive tests at Selkirk (R. F. & T. E. A.) 488
Commodity cards, Standard classification (C. D. O. A.) 478
Competition, Boiler patch..26*, 79*, 200*, 232*, 370*
Competition, Subsidized, Taxes and, by Robert S. Henry 538
Compressed air, Cutting cost of..... 152§
Concentricity, Wheel, Device for checking.. 405*
Confusion in the front office ..... 514§
Connection, Locomotive-tender, Type 3VX, Barco Mfg. Co. 189*
Connection, Steam-heat, FT-2, Barco Mfg. Co. 413*
Conventions
Attendance at—Asset or liability?.... 399§
Editor looks at 510
Guest speakers at ..... 510§
Manual for procedures ..... 510§
Microphones, at ..... 512§
Program changes ..... 513§
Corrosion on firebox sheets (M. B. A.).... 457
Cor-Ten hopper cars show low weight loss.. 149
Cor-Ten vs. copper steel 60*
Cost
Car repairs ..... 541§
Diesel-electric locomotive
Operation and maintenance..439, 272, 288§, 359§ 361‡
Repair ..... 191§
Locomotive, Surplus (R. F. & T. E. A.) 491
Maintenance, of friction vs. roller-bearing locomotives (Mech. Div.) 273
Costello, D. V., Idea of a stock car..... 157
Cotter, Spring, for lifting scale, by Frank Bentley 371*
Counterbalancing: Semi-crossbalancing driving wheels (Sou. Pac.) 389*
Coupler, Box-car, repairs (Erie)..... 553*
Coupler report (Mech. Div.) 255
Couplers pulled out (C. D. O. A.)..... 481
Coverdale & Colpitts report on streamliners 127
Cracks, Intercrystalline, in locomotive boilers (Mech. Div.) 262*
Crane, Gantry, for straightening hopper-car top rails (Ill. Cen.) 28*
Cranes (see Material handling equipment)
Crank-pin failures (Mech. Div.)..... 274
Crank pins, Locomotive, Applying ..... 542§
Crawford, J. C., Saving fuel (R. F. & T. E. A.) 489
Crossbalancing, Semi, driving wheels, by Morris P. Taylor (Sou. Pac.)..... 389*
Crossett, J. W., Quenched and tempered locomotive forgings 219*
Crosshead guides, Device for locating..... 113*
Crown-sheet patches, Types of 411*
Cullen-Friestedt Co., Welding positioner.... 237*
Cut-off machine, Radiac Type M, A. P. DeSano & Son 424*
Cutting equipment (see Welding and cutting equipment)
Cutting tools, Standardized, Carboloy Co..... 420*
Cylinder-power, High-speed locomotive, measurement, by L. K. Botteron 526

D

Davidson, Edward, Assistant chief inspector of locomotives 208
Davies, G. M., Boiler questions and answers 25, 163, 204, 233, 330, 372, 411, 545
Dearborn Chemical Co., Automatic blowoff system 26*
Decelostat operation (R. F. & T. E. A.)... 497
Defense, National
Budd's, Ralph, progress report..... 332†
Buford, C. H. (Mech. Div.).....247, 287§
Commission, appointments 295
Henry, R. S., Railroads ready....511§, 539
Pelley, J. J., Railroads ready 296
Railway Business Assn. study..... 332†
Ryerson, Edward L., Steel production ample ..... 515†
Shop employment and ..... 400§
Supervisors, Locomotive, Training..... 316§
Transportation, Adequacy of ..... 515†
Troop mobilization, Providing for..... 316§
Deflector plates, Cold-air (M. B. A.)..... 458*
Delaware & Hudson
Boiler, Fusion-welded (M. B. A.).274, 457
Coaches, Lightweight 8*
Locomotives, 4-6-6-4 ..... 337*
Denver & Rio Grande Western
Box car, Automobile ..... .62*
Firebox materials, Service of, by Ray McBrian (M. B. A.) 531*
Depreciation orders, Equipment..37, 170, 208, 297, 518
DeSano, A. P., & Son, Radiac Type M cut-off machine 424*
Devices, Shop (see Shop kinks)
DeVilbiss Co.
Air transformer for spray-painting process 199*
Spray gun for decorative finishing 27*

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

DeWalt Products Corp., Type GE woodworking machine 420*
Dickerman, W. C., elected to Ordnance League 241
Diesel engines (see Engines, Diesel)
Door opener, Air-operated (I. C.) 331*
Doors, Hopper-car, Safe-ending (Ill. Cen.) .. 29*
Double-heading forbidden ..... 206†
Draft, Action of, on fuel bed, Moving pictures 488
Draft bill opposed by brotherhoods ..... 374†
Drawbars, Gage for measuring length of, by A. D. Hollis 202*
Drilling, Multiple, operations, (I. C.) 325*
Dri-Steam Valve Sales Corp., Improved steam dryer 373*
Driving box (see Box, Driving)
Drop-pit table, 60-ton, Whiting 27*
Dry pipe, Design of, in boilers without steam dome 233
Duff-Norton Mfg. Co., 20-ton motor-operated jack 323*
Dust collector unit, Air Master, Cincinnati Electrical Tool Co. 156*
Dynetric balancing machines, Gisholt Machine Co. 158*

E

Edna Brass Mfg. Co., Oil divider for lubricating system 413*
Education
  Brake, Air, instructions for division officers ..... 190§
  Program of, for turret-lathe operators, Warner & Swasey Co. ..... 242‡
Eksergian, Rupen, Dr., Worcester Reed Warner medal 38
Electro-Chemical Engrg. Corp., Automatic blow-off system 26*
Electro-Motive Corp., Diesel-electric freight locomotive ..... 426†
Elliott, Edward C., Neglected high pressures (M. B. A.) 452
Ellis, D. C., Address (R. F. & T. E. A.) .. 488
Elwell-Parker Electric Co., Triple-lift fork truck 417*
Embrittlement in boiler
  Mech. Div. report 263*
  Schroeder, W. C. (M. B. A.) 182*
Employee relations: Shop Crafts to settle jurisdictional disputes 126
Employment, Shop, and national defense .... 400§
Engine, Diesel
  Failures, by H. J. Vander 232
  Instructions for maintaining (A. T. & S. F.) 202, 409
  Turbo-charged (G. E.-Alco) 380*
Engineering Societies Library, Microfilm copies 242
Engines, Oil, Supercharged, Waukesha-Hesselman (N. Y. S. & W.) 304*
Equipment, Shop, needs replacement. 225§, 359§
Erie, Handling device for punching steel plate 404*
Evaporation, Boiler, Determining ..... 330, 362‡
Exhibits
  Allied Ry. Supply Assn. 394
  Value of, to the supervisor ..... 399§

F

Failures, Crank pin (Mech. Div.) 274
Failures, Magnaflux testing to prevent ..... 400§
Fare, Two-cent, for eastern roads ..... 122†
Faus, H. W., Crank-pin failures (Mech. Div.) 277
Feedwater, Boiler, Chemical treatment of (M. B. A.) 462
Feedwater heaters
  Coffin, Renewing tubes in a 26*
  Exhaust steam (Mech. Div.) 271
Feedwater temperature, Increasing (M. B. A.) 459
Firebox
  Materials and construction (Mech. Div.) 276
  Materials, Service of, by Ray McBrian 531*
  Sheets, Holding and welding 373
  Sheets, Pitting and corrosion on (M. B. A.) 457
  Welding (M. B. A.) 453
Firing practice
  Coal (R. F. & T. E. A.) 504
  Oil (R. F. & T. E. A.) 499
  Improper, and water circulation (M. B. A.) 460
Flange-Jacks, Garlock Packing Co. 166*
Flies, Combating (C. & N. W.) 402*
Flue application (M. B. A.) 468*
Flue shop at Pen Argyl (L. & N. E.) 76*
Foremen (see Supervisors)
Forging furnace, Mahr Mfg. Co. 417*
Forgings, Locomotive, Quenched and tempered, by L. E. Grant and J. W. Crossett (C. M. St. P. & P.) 219*
Forming steel car parts (C. B. & Q.) 234*
Foster Machine Co., Superfinishing heads for engine lathes 419*
Fox, W. C., Unit pressures on oil-lubricated bearings ..... 238‡
Franey, M. D., Damaging effects of water in cylinders ..... 361‡
Fry, Lawford H., Question of Diesel costs .. 361‡
Fuel
  Coal
    Equivalents of fuels and power (R. F. & T. E. A.) 501
    Fine, Mechanical cleaning of 500
    Selection of (R. F. & T. E. A.) 505
  Efficiency record, 1939 ..... 170†
  Economy, Chief dispatcher's views on, by T. O. Weeks (R. F. & T. E. A.) ..... 488, 510§
  Saving, by J. G. Crawford (R. F. & T. E. A.) 489
Fuel and Traveling Engineers' Assn.
  Meeting 356, 391, 487
  Address by
    Ellis, D. C. 488
    Henry, Robert S. 536
    Weeks, T. O. ..... 488, 510§
  Election of officers 488
  Locomotives
    Diesel-electric, Road foreman and, by Leo W. Powell 505
    Tests, at Selkirk, by W. E. Collins .. 488
    Turbine and condensing 144*, 503
    Utilization 490
  Reports and papers
    Boilers, Stationary, Coal-fired 503
    Brake equipment, Locomotive, No. 8-ET 494*
    Coal equivalents of fuels and power .. 501
    Economy devices, Locomotive, New .. 488
    Fuel records and statistics 501
    Fuel saving, by J. G. Crawford 489
    Firing practice
      Coal 504
      Oil-burning 499
    Steam consumption of locomotive auxiliaries, by E. E. Chapman 492
Furnace
  Heat-treating and forging, Mahr Mfg. Co. 417*
  Rivet heating 235*

G

Gage, Fillet weld, General Electric Co. 165*
Gage for measuring drawbar lengths, by A. D. Hollis 202*
Garlock Packing Co., Flange-Jacks 166*
Gasoline, Gallons of, equivalent to one net ton of coal (R. F. & T. E. A.) 502
Gear, Draft
  And riding comfort (N. Y. C.) 94*
  Repairing (Erie) 553*
  Report (Mech. Div.) 255
Gear, Power reverse, Paxton-Mitchell Co. 413*
General Electric Co.
  Diesel engines, 660- and 1,000-hp 380*
  Gage, Fillet-weld 165*
  Speed-variator equipment 416*
  Weld recorder 35*
  Welder, Arc, Direct-current 420*
General Steel Castings Corp.
  Truck, Four-wheel passenger-car 294*
  Test: Furnace and firebox support and boiler waste sheets (Mech. Div.) 271
Geometric Tool Co.
  Grinder, No. 20 chaser 416*
  Threading machine, Double-spindle 233*
Germany, Boiler explosions in, by Wm. T. Hoecker ..... 362‡
Giddings & Lewis Machine Tool Co., Boring, drilling and milling machines 422*
Gill, H. V., Design, operation and maintenance of Diesel-electric locomotives (L. M. O. A.) 131*, 202, 409 437*
Gisholt Machine Co.
  Dynetric balancing machines 158*
  Multiple cutter turner 424*
Glazing methods (Can. Nat'l) 197*
Goetz-Voss Corp., Portable crank-pin grinder 419*
Goodrich awards ..... 517†
Grand Trunk Western, Carboloy tools on machining work 369*
Grant, L. E., Quenched and tempered locomotive forgings 219*
Grate bearers, Design of (M. B. A.) 457
Grates
  Equalizing the flow of air through, by S. H. Acker 140*
  Sloping, Why perpetuate ..... 109§
  Tuyere-type, 12-in., Hulson Grate Co. .. 412*
Gray accelerometer 350*
Gray, W. G., assistant mechanical engineer, A. A. R. 298*
Great Northern, Pendulum type cars ..... 126†
Green Bay & Western, 60-ton drop-pit table 27*
Grinder, Crank-pin, Portable, U. S. Metallic Packing Co. 419*
Grinding, Car-wheel, effects economy ..... 151§
Grinding machines (see Machine tools)
Grip, Emergency, for air motor throttle 409*
Gusset brace, Cross-sectional area of, Determining 372*

H

Hall, F. L., Tire-turning tool with cutter control 75*
Hall, J. M.
  Address (Mech. Div.) 249
  Responsibility of maintenance officer and federal inspector ..... 444, 511§
Hammer, Riveting, Air-operated, Ingersoll-Rand Co. 294*
Handling trains (see Train handling)
Hankins, F. W., Address (Mech. Div.) 248
Hardy, C. J., elected to Ordnance League .. 241
Harley, Edward, Determining boiler capacity 362‡
Harnischfeger Corp., Hansen welder 417*
Hartford Steam Boiler Inspection and Insurance Co., Failures of Diesel engine parts 232
Havens, Arthur, Water-column clean-out tool 371*
Heat balances—Steam and oil burning locomotives (R. F. & T. E. A.) 494
Heater cars for use with Diesel-electric locomotives (Ill. Cen.) 186*
Heidel, E. H., Reinforcement of defective boiler shells 206*
Hennessy Lubricator Co., Mechanical lubricator for A. A. R. journals 554*
Henry, Robert S., Address (Mechanical Assns.) ..... 511§, 536
High spots in railway affairs 36, 80, 122, 167, 206, 239, 295, 332, 374, 425, 515, 555
Hinds, H. E., Enginehouse problems of the present day (L. M. O. A.) 446
Hitch, C. B., Improving railroad service (L. M. O. A.) ..... 433, 512§
Hoecker, Wm. T., Boiler explosions in Germany ..... 362‡
Hoeffer eight-spindle machine for drilling brake- and spring-rigging pins (I. C.) 325*
Hoists (see Material Handling Equip.)
Hollis, A. D.
  Applying link trunnion bushings 78*
  Crosshead press fits 25
  Gage for measuring drawbar lengths .. 202*
Hooks (see Material Handling Equipment)
Hopper castings, Ash pan 370
Horsepower, Indicated, Heat-drop method of measuring (U. P.) 527
Hose, All-metal, Seamlex Co. 549*
Hot boxes (See Boxes, Journal)
Hulson Grate Co., 12-in. Tuyere-type grate 412*
Human life, High pressures of, by Edward C. Elliott (M. B. A.) 452
Human resources, Conservation of ..... 510§

I

Illinois Central
  Car-shop kinks 28*
  Heater cars, for use with Diesel-electric locomotives, by H. Anderson 186*
  Jigs, fixtures and devices at Paducah, by G. H. Raner 228*, 324*
  Water, Drinking, device for cooling .. 33*
  Water, Softened, for locomotives 36*
Ingersoll-Rand Co., Air-operated riveting hammer 294*
Injector
  Exhaust steam (Mech. Div.) 271
  Size, Determining 330
  Type 4000, Nathan Mfg. Co. 540*
Inspection, Car, Class A and Class B ..... 315§
Inspection equipment, Portable, Magnaflux Corp. 418*
Inspection, Locomotive
  Law, Results from (L. M. O. A.) 446
  Problems of the present day, by H. E. Hinds (L. M. O. A.) 446
  Rule 116(b) ..... 208†, 334†
Inspector, Federal, Responsibility of, by John M. Hall 444
Inspectors' titles, Locomotive, changed. 208†, 298‡
Instruction (see Education)
Interchange rules (see Rules, Interchange)
Interchange and billing (C. D. O. A.) 485
Intercrystalline cracks in locomotive boilers Mech. Div.) 262*
International Nickel Co., Nickel steel for locomotive boilers (M. B. A.) 463
Interstate Commerce Commission
  Bureau of Locomotive Inspection annual report ..... 52*, 150§
  Bureau of Safety
    Annual report 82
    City of San Francisco wreck. ....13, 21§
    Pioneer Zephyr wreck 107*, 110
  Decision delays 515
  Depreciation, Equipment, orders 37, 170, 208, 297, 518
  Inspection, Locomotive, rule 116(b) 208†, 334†

J

Jacks (see Material Handling Equipment)
Jigs and fixtures (see Shop Kinks)
Johnson, L. B., Oakite tank-car cleaning unit 364*
Journal Box Servicing Corp., Car-brass trimmer (Ill. Cen.) 32*

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Journal boxes (see Boxes, Journal)
Journal brass (see Brass, Journal)

K

Kansas City Southern, Southern Belle..... 523*
Kansas State Board for Vocational Education, Air-brake instructions for division officers ..... 191§

L

Labor and material prices (Mech. Div.)..... 269
Lagging, Block, Method of applying (Can. Nat'l) 161*
Landis Machine Co., Hand-feed adapter for turret-lathe head 79*
Lapping outfit, Dexter, Leavitt Machine Co. 424*
Lathe, Turret, head, Hand-feed adapter for, Landis Machine Co. 79*
Lathe, Turret, operators' service, Warner & Swasey Co. ..... 242†
Lathes (see Machine Tools)
Lathes, Engine, Superfinishing heads for, Foster Machine Co. 419*
Laying out shoes and wedges on a vertical turret lathe 545*
Leavitt Machine Co., Dexter lapping outfit.. 424*
Lehigh & New England
  Driving-box work 407*
  Flue repair shop at Pen Argyl 76*
Lehigh Valley
  Apprentices honored ..... 557†
  Hopper cars converted for cement..... 318*
Lewis Bolt & Nut Co., Staybolt-hole bushing 415*
Lewis-Shephard Sales Corp., Open-end hydraulic lift truck 422*
Lighting units, Tufflite, Westinghouse Elec. & Mfg. Co. 423*
Lincoln, James F., Arc Welding Foundation industrial progress award program 82
Loading rules (see Rules, Loading)
Loadings, Revenue freight-car (1937-40).... 425
Locomotive
  Availability .....65§, 225§
  Boilers (see Boilers, Locomotive)
  Construction (Mech. Div.) 271*
  Cylinders (see Cylinders)
  Diesel-electric
    Cost study .....359§, 361‡
    Design, operation and maintenance 131*, 202, 437*
    Handling the, by Leo W. Powell (R. F. & T. E. A.) 505
    Progress, 15 years of ..... 23§
    Steam and, comparisons ....22§, 65§, 238‡
    Switcher savings (Pacific Ry. Club).. 81
  Grates (see Grates)
  Horsepower (see Horsepower)
  Inspection report, Bureau of Locomotive Inspection 52*
  Obsolescence, Combating, (St. L.-S. W.) 310*
  Maintenance
    Diesel-electric, by H. V. Gill (L. M. O. A.) 437*
    For long runs, by Lee Robinson (L. M. O. A.) 443
  Oil-electric, Development and use of Mech. Div.) .....272, 288§
  Operation
    Double-heading forbidden ..... 206†
    Diesel-electric
      C. & N. W. "400's" complete 300,000 miles ..... 333†
      Gill, H. V., (L. M. O. A.)..... 437*
      Handling the Diesel-electric, by Leo W. Powell (R. F. & T. E. A.).. 505
    Performance, B. & O. Diesel-electric daily ..... 169†
  Piston rods (see Rods, Piston)
  Purchases, 1934-1939 (I. C.)..... 310
  Steam and Diesel, comparisons 22§, 65§, 238‡
  Tenders (see Tenders)
  Turbine and condensing (R. F. & T. E. A.) 503
  Utilization, Locomotive (R. F. & T. E. A.) 490
Locomotive Finished Materials Co., Martin stoker 412*
Locomotive Maintenance Officers' Assn.
  Address by
    Ellis, D. S. 472
    Garber, O. A. 472
    Henry, Robert S. 536
    Sheehan, D. J. 472
  Advisory board ..... 510§
  Election of officers 433
  Papers
    Air-brake maintenance, future, Stewart, J. P. 440
    Enginehouse problems of the present day, by Hinds, H. E. 446
    Locomotive, Diesel-electric, design, operation and maintenance, by H. V. Gill 437*
    Locomotive maintenance for long runs, Robinson, Lee 443
Locomotive Maintenance Officers' Assn.—(*Continued*)
  Papers—(*Continued*)
    Machinery and tools in locomotive repairs, Use of, by D. J. Sheehan... 435
    Railroad service, Improving, by C. B. Hitch .....433, 512§
    Responsibility of locomotive maintenance officer and federal inspector, by John M. Hall .....444, 511§
  Meeting 391, 393, 432*
  Reorganization of ..... 513§
Locomotives
  Combustion-turbine, Proposed (R. F. & T. E. A.) 144*
  Diesel-electric (see also Trains, High-speed)
    Switchers
      660- and 1,000-hp. (Alco) 379*
      660- and 1,000-hp. (Baldwin) 56*
    2-8-2, M. & St. L., with stainless-steel boiler jacket 398*
    4-6-4, (General dimensions and boiler ratios) 44
    4-8-4
      Can. Nat'l (Montreal) .....171†, 187*
      C. M., St. P. & P. (Baldwin)..... 216*
      Table of general dimensions and boiler ratios 46, 104
    2-8-8-4, Southern Pacific (Lima)..... 1*
    4-6-6-4, D. & H. (Alco) 337*
    Ten-coupled (General dimensions and boiler ratios) 45
Long runs, Locomotive maintenance for, by Lee Robinson (L. M. O. A.) 443
Lubricants and lubrication (C. D. O. A.).. 477
Lubricating devices
  Oil divider, Edna Brass Mfg. Co..... 413*
  Spee-D filler neck, Reliance Machine & Stamping Works 415*
Lubrication
  Car and locomotive (Mech. Div.)..... 250
  Diesel-engine (A. T. & S. F.)....410, 439
Lubricator, Mechanical, for A. A. R. journals, Hennessy Lubricator Co. 554*
Lumber, Car, Treated wood for ..... 358§

M

Machine Tools
  Boring, drilling and milling machines, Giddings & Lewis Machine Tool Co. 422*
  Grinding machines
    Chaser, No. 20, Geometric Tool Co... 416*
    Disc, Double-end, Standard Electrical Tool Co. 423*
    Multipurpose, Norton Co. 79*
  Lathes
    Cutter, Multiple, turner for, Gisholt Machine Co. 424*
    Turret, in toolrooms 112*
    Turret, Ram type, Warner & Swasey Co. 166*
  Milling Machines
    Hydro-Tel, Cincinnati Milling Machine Co. 419*
    Rigidmil, Hydraulic, Sundstrand Machine Tool Co. 424*
Machinery and tools in locomotive repairs, Use of, by D. J. Sheehan (L. M. O. A.) 435
Magnaflux testing ..... 400§
Magnaflux Corp., Portable inspection equipment 418*
Mahr Mfg. Co., Heat-treating and forging furnace 417*
Maintenance, Locomotive (see Locomotive maintenance)
Maintenance, Car (see Car Maintenance)
Martin stoker 412*
Master Boilermakers Assn. (see Boilermakers' Assn.)
Material handling equipment
  Cranes
    Crawler, P. & H. Model 255 ..... 554*
    Tractor, with pneumatic tires, Silent Hoist Winch & Crane Co. 418*
  Hoist, Electric, Type WFBC, Whiting Corp. 423*
  Hooks, Lifting, for applying steel car sheets (Ill. Cen.) 29*
  Jacks
    Journal, Portable Plating & Equipment Co. 199*
    Journal, Two-speed, Buda Co. 416*
    20-ton motor-operated, Duff-Norton Mfg. Co. 323*
  Tractor with side-dump trailer (C. B. & Q.) 367*
  Trucks
    Hydraulic, Open-end, Lewis-Shephard Sales Corp. 422*
    Triple-lift fork, Elwell-Parker Electric Co. 417*
McBrian, Ray, Service of firebox materials (M. B. A.) 531*
Medallion, Rock Island 75*
Meister, C. L., Igloo sand drying house (A. C. L.) 544*
Memberships, Association, Building ..... 511§
Microfilm copies at Engineers' Library..... 242
Microphones at conventions ..... 512§
Mileages, Locomotive, Average, on ten roads (R. F. & T. E. A.) 490
Milling machines (see Machine tools)
Milling machine, Frame pedestal-jaw (Ill. Cen.) 228
Miner accelerometer 349*
Minneapolis & St. Louis, Locomotive with stainless-steel boiler jacket 398*
Missouri Pacific
  Chair cars, Rebuilt 118*
  Eagle trains 87*
"Modern Pioneers" in railroading 125
Monopoly minds in employee and customer relations ..... 542§
Moving pictures—Action of draft on fuel bed in firebox (R. F. & T. E. A.) 488
Murray, D. J., Mfg. Co., Automatic shut-off value 422*

N

Nathan Manufacturing Co., Type 4000 injector 540*
National Defense (see Defense, National)
New York Air Brake Co., Fiftieth birthday 358§
New York Central
  Crank-pin failures, by H. W. Faus (Mech. Div.) 277
  Moving pictures action of draft on fuel bed in firebox 488
  Tests
    Gear, Draft, recoil 94*, 258*
    Locomotive, at Selkirk 488
    Test rack for steam-heat connectors.. 196*
New York, New Haven & Hartford, Demounting wheels at Readville 70*
New York, Susquehanna & Western, Air-cooled rail cars (Alco) 303*
Norris, E. F., Monopoly mind in customer relations .....543§, 555†
Northern Pacific
  Grates, Locomotive, by S. H. Acker.... 140*
  Hopper cars, 50-ton (ACF) 137*
Northwest Carmen's Assn. (see Clubs and Associations)
Norton Company, Multipurpose grinder 79*
Nut, Self-locking, Boots, Scoville Mfg. Co. 237*

O

Oakite Products, Inc., Tank-car cleaning unit 364*
O'Brien, R. A., Intercrystalline cracks in locomotive boilers (Mech. Div.) 262*
Obsolescence, Locomotive, Combating, by J. L. Ryan (A. S. M. E.) 310*
Oil divider for lubricating system, Edna Brass Mfg. Co. 413*
Oil engines (see Engines, Oil)
Okadee Co., Blow-off valves 286*
Olds, Irving S., Steel industry ready to grow 519
Operation, Locomotive (see Locomotive operation)
Ostlind Valve Inc., Steam valve with a spinning disc 165*

P

Painting
  Report (C. D. O. A.) 483
  Underframes with car cement (Ill. Cen.) 31*
Painting equipment
  Air transformer for spray-painting process, DeVilbiss Co. 199*
  Spray gun for decorative finishing, DeVilbiss Co. 27*
  Spray pits at Centralia (Ill. Cen.) 31*
Patents: Modern Pioneers in railroading.... 125
Patterson, W. J., Address (Mech. Div.)..... 249
Pawling & Harnischfeger Model 255 crawler crane 554*
Paxton-Mitchell Co., Power reverse gear.... 413*
Pearce, E. S., Journal-box temperature 67§, 69*, 238‡
Pelley, J. J.
  1940 outlook 39
  Readiness and capacity of railroads.296, 517
Pension estimates ..... 167†
Performance, Locomotive (see Locomotive performance)
Pioneer Zephyr wreck .....107, 110§
Pioneers, Modern, in railroading 125
Piston rods (see Rods, Piston)
Pitting on firebox sheets (M. B. A.) 457
Platform for use in applying lagging (Ill. Cen.) 229*
Portable Plating & Equipment Co., Atlas journal jack 199*
Powell, Leo W., Road foreman and Diesel-electric locomotive (R. F. & T. E. A.).. 505
Press fits, by A. D. Hollis 25
Pressed Steel Car Co., Cor-Ten steel passenger coach 382*
Pressures, High, Some neglected, by Edward C. Elliott (M. B. A.) 452
Prices for labor and material (Mech. Div.) 269
Priest, H. M., Designing for high-tensile steels 15*

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Pullman Co.
Coach-sleeper, triple-deck 241*
Coach sleepers stimulate business..... 374†
Dept. of Justice suit 333, 376, 517
Punching steel plate, Handling device for (Erie) 404*
Pyle-National Co., Multi-vent research laboratory 335

Q

Quinn, M. A., The master boiler maker (M. B. A.) 451
Quiz on Railroads and Railroading ..... 426†

R

Rack, test, for steam-heat connectors (N. Y. C.) 196*
Rail cars (see Cars, Passenger)
Railroad, A, What is ..... 542§
Railroad service, Improving, by C. B. Hitch (L. M. O. A.) .....433, 512§
Railway Business Assn.
Railways and the Equipment and Supply Industry 557
Transportation and National Defense .. 332†
Raner, G. H., Shop jigs, fixtures and devices (Ill. Cen.) 228*, 324*
Raymond, A. A., Diesel switcher savings (Pac. Ry. Club) 81
Recorder, train-signal, automatic, Valve Pilot Corp. 285*
Refrigeration: Temperature comparisons in overhead ice and conventional end-bunker cars (Can. Nat'l) 215
Reliance Machine & Stamping Works, Spee-D filler neck 415*
Repair, Car, yards, Walkways for 119*
Repairs, Coupler and draft-gear (Erie).... 553*
Repairs, Freight-Car
Costs ..... 541§
Hopper cars converted for cement (L. V.) 318*
Labor-saving devices for, at Centralia (Ill. Cen.) 28*
Refrigerator car underframes 119*
Repairs, Locomotive
Diesel: Why are costs high? ..... 191§
Jigs, fixtures and devices for making, at Paducah (Ill. Cen.) 228*
Machinery and tools, Use of, in, (L. M. O. A.) 435
Republic Steel Corp. stainless steel plant at Massillon, Ohio 124
Research laboratory, Multi-vent, Pyle-National Co. 335
Research, What, has done for passenger service, by C. E. Smith ..... 555†
Research program—axles, crank pins and bearings (Mech. Div.) 274
Respirator filter cartridge, American Optical Co. 422*
Retirement Board personnel 208
Reverse gear (see Gear, Reverse)
Rheostat, Water, for testing Diesel locomotives, by C. C. Whittaker 162*
Ripley, C. T., Wheel maintenance (C. D. O. A.) 482
Rivet heating furnace 235*
Riveting hammer, Air-operated, Ingersoll-Rand Co. 294*
Rivets, Iron, Steel and alloy (M. B. A.).... 463
Rod, Piston
Design, safety features in (C. R. I. & P. Parter, Hydraulic, Sperry Products, Inc. 24*, 421*
Roesch, F. P., Cinder cutting and honeycombing (M. B. A.) 469
Rolling stock being reconditioned ..... 541§
Roof, Refrigerator car, Single-board 121*
Rules, Interchange: Arbitration Committee report (Mech. Div.) 265
Rule, Loading, reports
C. D. O. A. 484
Mech. Div. 261
Running boards, Slotted, Alan Wood Steel Co. 314
Russell, Frank E., Preventing boiler explosions due to low water ..... 238‡
Ryan, J. L., Combating locomotive obsolescence (St. L.-S. F.) 310*
Ryerson, Edward L., Steel production ample 515†

S

Safety awards (Harriman medals) 295
St. Louis-San Francisco
Grates, Locomotive, Equalizing flow of air through, by S. H. Acker..... 140*
Locomotive obsolescence, Combating, by J. L. Ryan 310*
Sand drying house, Igloo (A. C. L.)..... 544*
Sash cleaning and glazing methods (Can. Nat'l) 197*
Saw, Cold, for cutting off worn ends hopper-car doors (Ill. Cen.) 29*
Schroeder, W. C.
Embrittlement in boilers (M. B. A.).... 182*
Intercrystalline cracks in locomotive boilers (Mech. Div.) 262*
Scoville Mfg. Co., Boots self-locking nut.... 237*
Seamlex Co., All-metal hose 549*
Sheehan, D. J., Use of Machinery and tools in locomotive repairs (L. M. O. A.).... 435
Shoes and wedges, Laying out, on a vertical turret lathe 545*
Shop crafts to settle jurisdictional disputes.. 126
Shop, Flue repair, at Pen Argyl (L. & N. E.) 76*
Shop kinks
Box, Driving, work at Pen Argyl (L. & N. E.) 407*
Brake, Air, shop devices (C. M., St. P. & P.) 550*
Bucking bar for steel car work 322*
Clean-out tool for water columns, by Arthur Havens 371*
Cotter, Spring, for lifting scale, by Frank Bentley 371*
Countersinking grease holes (Ill. Cen.) 231*
Crane, Cantry, for straightening hopper-car top rails (Ill. Cen.) 28*
Device for
Applying Walschaert link trunnion bushings by screw pressure, by A. D. Hollis 78*
Checking wheel concentricity 405*
Cooling drinking water (Ill. Cen.).. 33*
Handling, punching steel plate (Erie) 404*
Holding locomotive brasses for machining (I. C.) 326*
Holding locomotive rods on a milling machine (Ill. Cen.) 232
Holding main crank pins while drilling center holes (Ill. Cen.) 228*
Locating guides with multiple-bearing crossheads 113*
Door opener, Air-operated (I. C.)..... 331*
Doors, Hopper-car, Safe ending (Ill. Cen.) 29*
Drilling brake- and spring-rigging pins (I. C.) 325*
Drilling, Multiple, operations (I. C.).. 325*
Furnace, Rivet-heating 235*
Gage for measuring drawbar lengths, by A. D. Hollis 202*
Grip, Emergency, for air motor throttle 409*
Hooks for handling
Applying driving tires 231*
Driving boxes 231*
Steel car sheets (Ill. Cen.) 28*
Jig for
Drilling gib-bolt holes in a crosshead (Ill. Cen.) 228*
Holding crown brasses on a vertical turret lathe (I. C.) 326*
Holding radius-bar guides (Ill. Cen.) 325*
Lifting driving-wheel tires (Ill. Cen.).. 230*
Milling machine, Frame pedestal-jaw (Ill. Cen.) 228*
Pipe shop devices (C. M., St. P. & P.) 550*
Platform for use in applying lagging (Ill. Cen.) 231*
Punching steel plate, Handling device for (Erie) 404*
Saw, Cold, for cutting off worn ends of hopper-car doors (Ill. Cen.) 29*
Slotting rod bushings on a shaper..... 202*
Straightening car parts (Ill. Cen.)..... 28*
Test rack for steam heat connectors (N. Y. C.) 196*
Tongs for handling rivets 235*
Tool for cutting fibre liners (Ill. Cen.).. 228
Truing worn multiple-wear guides (I. C.) 325*
Wheeling locomotives (Ill. Cen.) 324*
Wheel stick eliminates journal damage.. 322*
Shop operation—electrical welding (C. D. O. A.) 475
Shop, Wheel, at Readville (N. Y., N. H. & H.) 72*
Shriver, George M., Goodrich award ..... 517†
Sillcox, L. K., Braking trains under modern conditions (Car Foremen's Assn. of Chicago) 240
Slotting rod bushings on a shaper 202*
Smith, C. E., What research has done for passenger service ..... 555†
Smith, R. H., Locomotive heart of railroad plant ..... 555†
Smoke reduction in North Jersey ..... 170†
Snubbers, Truck-spring, by W. S. Spieth (Northwest Carmen's Assn.) 175*
Southern Pacific
Boiler explosions due to low water, Preventing, by Frank E. Russell ..... 238‡
City of San Francisco wreck .....13, 21§
Locomotives, 2-8-8-4 ..... 1*
Specifications for materials (Mech. Div.)... 270
Spee-D filler neck, Reliance Machine & Stamping Works 415*
Speed pressure control (R. F. & T. E. A.) 498
Speed-variator equipment, General Electric Co. 416*
Speeds, Freight-train
Average in 1939 ..... 169†
How to increase ..... 226§
Speeds, Passenger-train, Mile-a-minute ..... 36†
Sperry Products, Inc., Piston-rod parter.... 421*
Spieth, W. S., Truck spring snubbers (Northwest Carmen's Assn.) 175*
Spotter, Model E., Whiting Corp. 418*
Spray-painting equipment (see Painting equipment)
Spring band, Locomotive, Standard Brake Shoe & Fdry. Co. 415*
Spring, Truck, snubbers, by W. S. Spieth.. 175*
Springs, Carbon-steel, Reconditioning (Can. Nat'l) 201*
Standard Brake Shoe & Fdry. Co., Locomotive spring band 415*
Standard Electrical Tool Co., Double-end disc grinder 423*
Staybolt hole bushing, Lewis Bolt & Nut Co. 415*
Staybolts
Applying, by welding (M. B. A.) 456*
Calculating area supported by 25
Unequally-spaced, Area supported by... 372*
Steam consumption of locomotive auxiliaries, by E. E. Chapman (R. F. & T. E. A.).. 492
Steam dryer, Improved, Dri-Steam Valve Sales Corp. 373*
Steam-heat connection (see Connection, Steam-heat)
Steam's future—A warning? ..... 513§
Steel industry ready to grow, Irving S. Olds 519
Steel production ample 515
Steels
High-tensile
And weight reduction, by V. R. Willoughby 223
Designing for, by H. M. Priest..... 15*
Tool, Red Tiger, Bethlehem Steel Co.... 236*
USS Cor-Ten vs. Copper 60*
Stewart, J. P., Future air-brake maintenance 440
Stoker screws, Flame-hardened ..... 191§
Stokers, Locomotive
Berkley Machine Works & Fdry. Co... 414*
Martin, Locomotive Finished Materials Co. 412*
Stone, Royal A., Judge, Collective bargaining ..... 515†
Strahl formula for determining capacity of steam locomotive 45
Straightening car parts (Ill. Cen.) 28*
Supervisors
Foremen
Enginehouse, Job of the ..... 511§
Know freight-car details ..... 110§
Road, and Diesel-electric locomotive, by Leo W. Powell (R. F. & T. E. A.) 505
Should have a chance ..... 109§
Locomotive, Training ..... 316§
Sundstrand Machine Tool Co., Hydraulic Rigidmil 424*
Switching movements, Controlling (R. F. & T. E. A.) 506
Symes, J. M., The car department in rail transportation 473
Symington accelerometer 350*

T

Tapgun, No. 8, Black & Decker Mfg. Co... 419*
Taxes and subsidized competition, by Robert S. Henry 538
Taylor, Morris P., Semi-crossbalancing driving wheels (Sou. Pac.) 389*
Temperature comparisons in overhead ice and conventional end-bunker refrigerator cars (Can. Nat'l) 215
Templin, R. L., Longstreth medal 241
Tender cistern, maintenance (M. B. A.).... 471
Tenders, 14-wheel, Union Pacific 386*
Testing
Machine, Templin 3,000,000-lb., Aluminum Co. of America 124*
Magnaflux ..... 400§
Steam-heat connectors (N. Y. C.)..... 196*
Test rack (see Rack, Test)
Tests
Boiler, Locomotive (A. S. M. E.)..... 47*
Draft gear (N. Y. C.) 94*
Draft-gear recoil (Mech. Div.) 258*
Furnace and firebox support and boiler waste sheets (Mech. Div.)..... 271
Grate, Locomotive, by S. H. Acker.... 140*
Locomotive at Selkirk (N. Y. C.)..... 488
Refrigerator car (Can. Nat'l) 215
Steel—Cor-Ten, USS, vs. copper 60*
Truck-spring snubbers, by W. S. Spieth 175*
Truck, Freight-car (A. A. R.)..... 345*
Threading machines
Double-spindle, Geometric Tool Co..... 233*
Model C, Beaver Pipe Tools, Inc..... 423*
Tire-turning tool with cutter control, by F. L. Hall 75*
Tongs for handling rivets 235*
Train handling, by Leo W. Powell (R. F. & T. E. A.) 505
Trains, Freight, Colors for ..... 122†
Trains, High-speed
C. B. & Q., 17-car stainless-steel ..... 296†
Coverdale & Colpitts report on 127
K. C. S.-L. & A. Southern Belle..... 523
Missouri Pacific Eagles 87*
Transportation, Adequacy of, Ralph Budd.. 515†
Transportation, Omnibus, bill S. 2009 (Wheeler-Lea) .....374†, 399§

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Trip with the fireman—Oil-burning firing practice (R. F. & T. E. A.) 499
Trucks and tractors (see Material Handling Equipment)
Truck-spring snubbers, by W. S. Spieth (Northwest Carmen's Assn.) 175*
Trucks, Car, Passenger, Four-wheel, General Steel Castings Corp. 294*
Trucks, Freight-car
  Arch-bar truck rule modifications 82
  Tests (A. A. R.) 345*
  Unit truck and brake beam, Unit Truck Corp. 286*
Truing worn multiple-wear guides (I. C.).. 325*
Trumbull, A. G., Problems of boiler maintenance (M. B. A.) 451
Tube and flue application
  M. B. A. report 468*
  Possible, on U. S. R. A. 2-8-2 B type locomotives, by J. L. Ryan 311
Tube-sheet layouts, Reproportioned (St. L.-S. F.) 312
Tubing of carbon and alloy steel, AGA Metal Tube Co. 205*

U

Underframe, Refrigerator car, repairs 119*
Unemployed, Increased benefit payments to.. 520
Unemployment, Technological ..... 190§
Union Pacific
  Horsepower, Indicated, Heat-drop method of measuring 527
  Tenders, 14-wheel 386*
  Wheels, Wrought-steel, Thermal cracking of (Mech. Div.) 254
Unions, AFL RR, progress 559
Unit Truck Corp., Unit truck and brake beam 286*
U. S. Metallic Packing Co., Portable crank-pin grinder 419*
Utilization, Locomotive (see Locomotive utilization)

V

Valve events, Effect of, on locomotive operation, by J. L. Ryan 310
Valve Pilot Corp., Automatic train-signal recorder 285*
Valves
  Blow-off, Okadee Co. 286*
  Reducing, Combined governor and, for water-raising systems, Westinghouse Air Brake Co. 294*
  Safety, Determining size of 330
  Shut-off, Automatic, D. J. Murray Mfg. Co. 422*
  Steam, with a spinning disc, Ostlind Valve Inc. 165*
Vander, H. J., Failures of Diesel engine parts 232
Vanderbilt University, Draft distribution in locomotive fireboxes, by S. H. Acker.... 140*
Vapor Car Heating Co., Thermo-pressure cleaning machine 331*
Vaughn, Henry Hague, honorary member A. S. M. E. 38
Verity, George M., honored 334

W

Wage payments dependent on earnings .... 122†
Wallace, M. C., M. & St. L. locomotive with stainless-steel boiler jacket 398*
Walt Wyre
  Circumstantial Evidence 153*
  Flock of troubles 327*
  It's an Ill Wind..... 546*
  The other fellow's job 114*
  Water on the Troubled Oil 290*
Walkways, Car yard 119*
Warner & Swasey Co.
  Educational program for turret-lathe operators ..... 242‡
  Lathe, ram-type turret 166*
Water circulation, Improving, in the boiler (M. B. A.) 459
Water-column clean-out tool, by Arthur Havens 371*
Water, Drinking, Cooling (Ill. Cen.) 33*
Water, Softened, for locomotives (Ill. Cen.) 36†
Waugh Equipment Co., Draft gears and riding comfort (N. Y. C.) 94*
Waukesha-Hesselman supercharged oil engine (N. Y. S. & W.) 304*
Weeks, T. O., Chief dispatcher's views on fuel economy (R. F. & T. E. A.)....488, 510§
Weight reduction, Freight-car, by V. R. Willoughby 223
Welding
  Electric (C. D. O. A.) 475
  Oxyacetylene and electric processes in boiler and tender work (M. B. A.).. 453*
  Spot, coaches (D. & H.) 9
Welding and cutting equipment
  Gage for checking fillet-weld size, General Electric Co. 165*
  Gas cutter, Planograph, Air Reduction Sales Co. 113*
  Hansen welder, Harnischfeger Corp.... 417*
  Remote control for arc welders, Wilson Welder and Metals Co. 205*
  Spot-welding machine, Hydromatic (C. M., St. P. & P.) 529*
  Weld recorder, General Electric Co..... 35*
  Welder, Arc, Direct-current, General Electric Co. 420*
  Welder, Flex-Arc, Westinghouse Elec. & Mfg. Co. 418*
  Welding positioner, Cullen-Friestedt Co. 237*
Western Maryland, All-welded flat cars (Greenville) 181*
Westinghouse Air Brake Co., Combined governor and reducing valve for water-raising systems 294*
Westinghouse Elec. & Mfg. Co.
  Tufflite concentrators 423*
  Welder, Flex-Arc 418*
Wheel press fits, by A. D. Hollis 25
Wheel report (Mech. Div.) 251
Wheel stick eliminates journal damage 322*
Wheeler-Lea omnibus transportation bill S. 3009 .....374†, 399§
Wheeling locomotives (Ill. Cen.) 324*
Wheels, Car
  Concentricity, Device for checking 405*
  Demounting, at Readville (N. Y. N. H. & H.) 70*
  Grinding, effects economies ..... 151§
  Maintenance of (C. D. O. A.) 482
Wheels, Driving, Semi-crossbalancing (Sou. Pac.) 389*
Whiting Corp.
  Drop pit table, 60-ton 27*
  Hoist, Electric, Type WFBC 423*
  Spotter, Model E. 418*
Whittaker, C. C., Water rheostat for testing Diesel locomotives 162*
Williamson, F. E., Goodrich award ..... 517†
Willoughby, V. R., Freight-car weight reduction 223
Wilson Welder and Metals Co., Remote control for arc welders 205*
Window cleaning and glazing methods at Pt. St. Charles (Can. Nat'l) 197*
Wood, Treated, for car lumber ..... 358§
Woodard, William E., Henderson medal 241
Woodworking machine, Type GE, DeWalt Products Corp. 420*
Wrecks (see Accidents)

PERSONAL MENTION

Akins, D. W. 430
Allen, H. D. 86
Anderson, J. J. 85
Armstrong, J. H. 302
Austin, Frank Stearns 378

Bair, Albert H. 302
Baker, Philip 244
Bell, Norman 335
Bergstrom, H. E. 42
Bishop, Benjamin 42
Bloom, C. E. 173
Bohnstengel, Walter 301
Bonnet, E. S. 430
Bordeau, H. A. 42
Bowman, George P. 174
Bricher, N. J. 522
Briers, P. T. 86
Britton, R. D. 430
Brooks, C. P. 244, 335
Brown, F. S. 335
Buck, Elwood R. 210, 244*
Burkley, H. J. 378

Cantrell, H. J. 210
Carter, T. C. 173
Chamberlain, Samuel A. 522
Chapman, E. E. 301
Chase, Daniel K. 85
Christy, Charles L. 173
Clark, F. B. 560
Clark, J. Allen 42, 86
Clarke, G. A. 244
Clyde, J. D. 430
Coleman, A. E. 173
Collins, W. F. 42, 85
Connal, William Ferguson 130*
Cousins, J. D. .....
Cover, H. T. 85*
Crabbs, W. Joseph 430*
Cyr, E. J. 173
Cyr, J. W. 173

Davenport, James E. 41
Davis, John E. 378*
Davis, W. R. 86
Denney, F. R. 378
Deno, C. F. 173, 522
Dickie, W. D. 522
Douglas, J. W. 174
Downey, L. W. 430
Dunham, Walter E. 86, 130*

Eaton, Edgar 173
Evans, T. H. 173

Fahey, Fred. J. 522
Farley, C. E. 173, 210
Farley, Joseph D. 210
Faulds, P. P. 42
Foley, L. V. 42
Forster, C. T. 301
Frederiks, T. R. 85
Friend, J. E. 378
Fuller, H. G. 173

Garretson, J. E. 86
Geidenberger, H. L. 430
Giles, Charles F. 86
Gilleland, G. W. 560
Goebel, R. C. 335
Goodwin, E. G. 41
Gorey, Robert Charles, Sr. 86
Green, Charles 522
Gruenberg, Otto C. 430, 522*
Gugler, H. C. 173
Gunning, A. C. 173

Hall, F. L. 378
Hall, James E. 335
Hall, U. K. 174
Harrison, J. Lee 244
Hartley, L. A. 302
Hawkins, P. D. 301
Hayes, D. J. 173
Hess, George Franklin 210*
Hessberger, Peter 173
Hinerman, W. V. 41
Hogan, C. S. 173, 210
Hornig, E. O. 430

Irish, J. L. 430

Jackson, W. R. 244
Jennings, R. V. K. 244
Johnson, E. L. 41*
Johnson, F. C. 174
Jones, Harvey H. 210
Jones, L. 335

Kann, A. G. 335
Karibo, J. J. 42
Kelin, H. S. 378
Kelly, M. M. 522
Kennedy, John 130, 173
Kirkpatrick, F. R. 86
Konsit, H. 430

Lam, E. L. 86
Lawler, G. M. 244, 301
Lenoski, L. 522
Leonard, J. W. 86
Lind, K. E. 522

Mahoney, Robert 42
Marks, J. L. 244
Martin, J. A. 174
Mattice, S. G. 430
Mays, C. S. 41
McCarthy, J. W. 173
McCullough, H. C. 173
McLeod, J. E. 86
McNeil, J. S. 174
McRae, J. 174
McSweeney, E. J. 335
Medlock, Walter 173
Meyers, D. N. 173
Mills, Harry E. 244
Mitchell, E. C. 522
Mitchell, Frank Kenneth 522
Mitchell, P. R. 522
Moore, H. G. 302
Morris, John S. 173
Moses, Dale J. 42
Mueller, S. E. 173
Mullens, A. R. 430
Myers, L. S. 336

Naive, M. T. 302
Neill, J. 174
Nelson, Martin H. 42
Noell, W. A. 244
Noland, Jesse T. 522
Nottingham, M. J. 173

Parnaby, C. L. 302
Parsons, Charles F. 522
Pasewick, Joseph V. 210
Payne, T. J. 173, 210
Pease, Charles A. 522
Pettry, C. M. 42
Pond, C. E. 41
Porter, W. B. 86
Powell, W. H. 42
Preun, T. L. 244, 378
Protz, Otto J. 41*
Pyne, R. A. 210

Quinn, M. M. 42

Reed, H. J. 130
Rees, Harry 378
Renner, Fred. H. 522
Retterer, R. W. 522
Root, David G. 244

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Rose, John O. 244
Ruiter, A. R. 301
Ryan, John F. 522, 560*

Sanders, E. J. 210
Sanders, George 301
Savage, Thomas E. 42*
Schmalzried, William 430
Schuette, L. E. 522
Schultz, W. H. 560
Schuster, L. R. 335, 430*
Schwartz, William 173
Sheffer, R. W. 85
Smires, Harvey 42
Smith, B. H. 130, 173
Smith, Donald M. 522
Smith, H. M. 210
Smith, Mark P. 244
Smith, W. C. 244, 378
Speier, J. A. 210
Spence, C. H. 378
Steeves, Cuthbert 42
Stewart, H. A. 41
Stewart, M. G. 42
Sullivan, J. L. 210
Swanson, F. J. 302
Swartwood, C. N. 522
Sylvester, I. I. 210

Taylor, Frank W. 560
Taylor, William H. 302
Thomas, August 173
Thomas, Paul 42, 378
Thorson, A. W. 210
Topping, Frank J. 86, 173*
Trachta, Gerald P. 301*
Turner, Frank C. 336
Twist, George 130

Uhrig, Jacob 301

Vick, Sam 522
Vinsant, H. C. 378

Waller, Fred. 522
Wardwell, W. C. 85
Warning, G. H. 430
Warren, J. A. 86
Webster, J. M. 173
White, Norman B. 244
Whittaker, F. 244
Wickhorst, Max. H. 86
Wilson, C. A. 244, 301*
Winget, Francis H. 42, 86
Wink, L. R. 130
Wolfe, H. O. 42
Wright, F. O. 335
Wright, H. C. 244, 302

Young, William Jasper 244

Zerbach, H. H. 244
Zweifel, John 244

PERSONAL MENTION OBITUARIES

Becker, H. G. 522
Brady, John L. 244
Brown, M. F. 210
Crabbs, William J. 430
Galloway, George Robert 336
Gibbs, George 302
Gugler, H. C. 522
Lewis, J. C. 430
Loree, L. F. 425
Milliken, Colonel James 130
Montgomery, Ora Clair 560
Pack, Alonzo 378*
Phillips, Arthur G. 244
Regan, F. J. 560
Russell, Samuel 244
Schroeder, J. H. 42
Scudder, Charles J. 86
Trout, William L. 336*
Warne, Charles C. 378
Wilson, Clarence L. 169
Wintersteen, John 336*
Wymer, Charles J. 302

SUPPLY TRADE NOTES

Air Reduction Sales Co.....209, 299, 300, 335
Alcock, George W. 209*
Alden, John W. 300
Allderdice, Norman 172
Allegheny Ludlum Steel Corp..243, 299, 300, 520
Allen, C. D. 243
Allen, Robert G. 377, 427*
Allison, R. P. 521
American Brake Shoe & Foundry Co. 127, 172, 243, 428, 521, 560
American Car and Foundry Co.....84, 129, 559
American Locomotive Co.....40, 127, 299, 521
American Steel Foundries 172, 377
Anchors, E. H. 299
Andrew, C. G. 209
Ardco Manufacturing Co. 40
Association of Manufacturers of Chilled Car Wheels 84
Austin, E. H. 171

Babcock & Wilcox Tube Co. 84, 521
Baldwin Locomotive Works.....40, 129, 172
Barber, F. L. 40
Barnes, William W. 335
Barton, H. J. 520
Becker, Max F. 300*
Beckette, E. S. 335
Beggs, J. C. 84
Bendix-Westinghouse Automotive Air Brake Co. 84
Berriman, J. W. 127
Bethlehem Steel Co. 127
Bettendorf Company, The 299, 427
Birdsboro Steel Foundry & Machine Co.... 84
Black, W. M. 560
Blackmore, George A. 41, 243, 559
Block, L. E. 243
Blume, W. A. 243
Boeckler, Neal E. 300
Boyne, C. B. 243
Brake Equipment & Supply Company, The.. 299
Brandenstein, E. W. 172
Breeze, William K. 128
Brendel, Louis H. 40
Brill, J. G. Co. 84
Brooks, Harold S. 127*
Brown, A. M. 427
Brown, Truman B. 299
Budd, Edw. G., Mfg. Co. 377
Buell, S. Nelson 172
Bunting, Robert L. 172
Butterfield, C. H. 40

Canadian Car and Foundry Co., Ltd. 559
Canadian Locomotive Co., Ltd. 559
Cannon, R. A. 84
Carboloy Company, Inc. 520
Carnegie-Illinois Steel Corp. 40, 427
Carlson, Frank R. 427
Casgrain, George D. 300*, 335
Chadwick, Walter 40*
Champion Handbrake Corp. 40
Chapman, Frederick L. 427
Charlton, Edward J. 172
Charlton, R. A. 41
Chicago Pneumatic Tool Co. 427
Chicago Railway Equipment Co.....39, 427
Christianson, A. 209
Christy, P. J. 427
Church, Maynard D. 39
Clark, Claude L., Dr. 521
Class, George M. 427
Clause, Robert L. 299
Clingman, R. S. 559
Coffin, J. S., Jr., Co. 243, 521
Coffing Hoist Co. 171
Copper Iron and Steel Development Association 335
Cooke, Randolph B., Jr. 560
Copperweld Steel Co. 243, 299, 559
Cox, Arthur T. 299
Craig, Kenneth A. 127
Crocombe, W. E. 560
Crowe, John J. 209
Cunningham, Frank H. 560
Cutler-Hammer, Inc. 377

Dabney, W. C. 172
Davenport Besler Corp. 40
Davenport, James E. 40*
Deuble, Norman L. 243
Devoe & Raynolds Co., Inc. 172
DeWolf, John B. 128
Dickerman, William C. 127*
Diehl, C. A. 427
Dillon, John A. 39, 172
Dolan, Frank J. 127
Doody, J. W. 520
Duff-Norton Mfg. Co. 209, 243, 377, 427

Edwards, O. M., Co. 520
Elastic Stop Nut Corporation 300, 521
Electric Storage Battery Company.....39, 84
Elliott, J. H. 171
Emerson, J. B. 427
Erlandson, F. E. 172
Ettenger, E. L. 520

Felton, Samuel M. 377*
Fiala, A. M. 41
Flogaus, Howard A. 84
Floyd, W. I. 209
Forbes, Fred. W. 172
Forster, J. G. 427
Foseid, P. Robert 427
Frame, R. E. 40
Franklin Railway Supply Co., Inc. 209
Fraser, Duncan W. 127*
Fritschi, G. F. 40

Garlock Packing Company 172
Gay, H. B. 39
General Electric Company 172
General Steel Castings Corp. 39, 40, 335
Gibbs, S. W. 243
Gillick, L. H. 560*
Girdler, John B. 84
Gisholt Machine Co. 427, 520
Glaenzer, Harry 40*
Globe Steel Tubes Company 300, 520
Goetz, Mowry E. 335
Gold Car Heating & Lighting Co.....427, 560
Goodrich, B. F. Co. 41
Gordon, George L. 172
Graham-White Sander Corp. 560
Great Lakes Forge Co. 172
Gulledge, J. S. 41

Hafferkamp, Howard R. 84
Halderman, L. J. 127
Hall, C. R. 300
Halladay, H. F. 520
Hammond, Stevens H. 428
Harty, William 559
Harwood, Stephen G. 299
Hayes, Harry N. 171
Heckman, William H. 377
Higgins, Edward W. 172
Home Rubber Company 171
Hostettler, Donald C. 84
Houston & Jolles 172
Houston, George H. 172
Houston, J. V. 521
Huber, A. F. 521
Huffman, F. M. 127
Hunter, Roy 427
Hunt-Spiller Manufacturing Corp. 127
Hyland, J. L. 335
Hyland, Paul V. 428

Inland Steel Company 128, 243, 559
Institute of Scrap Iron & Steel 335
International Nickel Co., Inc.....39, 209
Iron & Steel Products, Inc. 84, 335
Irwin, Jay 171
Isaacs, James 39

Jackson, J. Eugene 335
Johnson, George H. 520
Johnson, H. S., Jr. 520
Johnson, Hobart S. 520
Johnson, Norman B. 209
Johnston, D. Bruce 172
Jones-Dabney Company 172
Jones & Laughlin Steel Corp. 128
Jones, Irving H. 520
Justus, R. G. 377

Kalas, Frank T. 39
Kearns, E. E. 172
Kelly, W. T., Jr. 127
Kempton, M. R. 209
Kimball, G. Cook 377
Kimsey, I. N. 41
Kirkpatrick, C. N. 171
Klasing Car Brake Co. 377
Koppers Coal Company, The 300
Koppers Company 299
Krape, R. D. 172*
Krautheim, W. C. 335
Krohn, Gilbert H. 300
Kuhn, H. J. 172
Kumer, J. R., Jr. 300

Laird, A. W. 520
Lampton, Frank W. 127
Landis, H. E., Jr. 209
Landis Machine Company 171
LaQue, F. L. 209
Lawrence, Fred. L. 299
Learned, Charles G. 377
LeGare, Arthur E. 39
Leighton, William M. 559
Lentz, W. L. 521*
Lewis, Paul C. 520
Lippert, Louis F. 300
Lohnes, John W. 84
Lukens Steel Co. 172
Lukenweld, Inc. 172
Lynch, W. J. 172

Macdonald, James 40
Mace, John S. 209
Mack, Ray D. 520
MacLaren, A. W. 172*
Magor Car Corp. 377
Manning, Maxwell & Moore, Inc.....40, 299
Marquette Railway Supply Co.....300, 335
Marvel, David T. 171
Marvel Equipment Corp. 560
McAlpine, W. J. 172
McAndrew, R. G. 521*
McColl, Robert B. 127*
McCollam, C. H. 84
McConway & Torley Corp. 40
McDonnell, John F. 171
McGrath, C. H. 127
Mersereau, E. C. 84
Miller, John W. 40
Miller-Lewis Railroad Equipment Corp. 39
Miner, W. H., Inc. 127, 129
Mitchell, C. R., Jr. 300
Moore Steam Turbine Corp. 39
Moore, W. B. 84
Morgan, Earl G. 559
Morgenstern, W. C. 299
Morton, Allen W. 299
Mudge, Dr., William A. 39, 209
Murphy, Frank T. 300

National Brake Beam Company, Inc., The.. 84
National Tube Company 171
New York Air Brake Company 520
Nivison, Robert B. 172
Norberg, R. C. 84

* Indicates photograph.

Oakite Products, Inc. 84
O'Brien, Maurice E. 128
Ogle Construction Co. 427
Okadee Co. 377
Olds, Irving S. 300*
Ortega, A. A. 377*
Oxweld Railroad Service Co.....335, 559

Packer, B. W. 428
Page, Arthur W. 41
Pardee, Powell 559
Parker, Frank 335
Partridge, S. C. 84
Peddle, J. B. 40
Perkins, R. W. 172
Pilliod Company, The 39
Pittsburgh Plate Glass Co. 209, 299
Pittsburgh Screw and Bolt Corp.....39, 172
Platten, J. Homer 84
Ploen, Curtiss W. 377
Proffit, R. P. 171
Pullman-Standard Car Mfg. Co. 209

Quickwork Co. 428

Raymond, Marshall D. 299
Republic Steel Corp. 335
Research Products Corp. 40
Reynolds, J. J. 172
Rhodes, C. H. 377
Rich, B. B. 377
Richardson, William H. 171
Robertson, William E. 127, 129*
Roller-Smith Company 335
Roy, Nereus Hubert 85*
Ryan Devices Company 299
Ryerson, Edward L., Jr. 243
Ryerson & Son., Inc., Joseph T. 127

Sahlin, Robert C. 172
Salisbury, Howard R. 335
Salter, R. L. 84
Sargent Co. 377
Sauer, H. C. 127
Schroeder, Charles A. 300
Scully, Thomas E. 39
Seydel, H. B. 335
Sheehan, William M. 40*
Snyder, George L. 172
Sonquist, Robert G. 172
Spackman, Herbert B. 128
Standard Car Sales, Inc. 40
Standard Car Truck Co. 39
Standard International Sales Corp. 172
Standard Railway Equipment Co. 172
Stansfield, C. T. 84
Stapleton, John E. 427*
Steinko, S. M. 428
Stettinius, Edward R., Jr. 299
Stocker, L. O. Company 559
Sudduth, H. N. 520
Superheater Company, The 39, 127

Taggert, William 243
Talbot, J. Thomas 428*
Taurman, A. 520
Taylor, Dr. A. Lloyd 84
Templeton, J. B. 171*
Templeton, Kenly & Company 171
Templeton, W. B. 171
Thomas, Edgar C. 171
Thomas, Harold B. 521
Thomas Machine Mfg. Co. 171
Thulin, C. N. 209
Thulin, Earl E. 209*
Timken, Henry H., Jr. 559
Timken Steel & Tube Co. 520
Timken Roller Bearing Co....84, 127, 171, 243, 300, 521, 559
Towne, R. W. 39
Travilla, James C., Jr. 335
Tyler, William C. 377

Union Railway Equip. Co. 427, 520
Union Switch & Signal Co. 41
United States Metallic Packing Co. 209
United States Steel Corp. 300
U. S. Steel Corp. of Delaware 377

Vanadium Corp. of America, The.....40, 84
Van Fleet, Herman 209
Van Meter, R. J. 39
Van Winkle, E. M. 172*
Vapor Car Heating Co. 560
Viloco Rwy. Equip. Co. 377
Volbrecht, R. 377

Wampler, William M. 84
Ward, F. R. 335
Waters, J. Berens 84
Watt, Herbert J. 40
Waugh Equipment Company 85
Weisenberger, F. A. 127
Westinghouse Air Brake Co.....41, 377, 559
Westinghouse Electric & Mfg. Co. 41
Wheatley, George 172
Whiting Corp., The 300, 428
Williams, John R. 84
Williams, Sidney D. 84*
Williams, W. W. 84
Williams, Watson 335
Wilner, Benton J. 128
Wilson, Harvey 521
Woodman, B. S. 335
Worthington Pump & Machinery Corp...39, 559
Wright, John E. 377

Yale & Towne Mfg. Co. 243

SUPPLY TRADE NOTES
OBITUARIES

Allen, Edwin W. 41, 300*
Bourne, George Lewis 243
Buenting, O. W. 429
Buker, J. E. 521
Campbell, Charles A. 429*
Chrysler, Walter P. 376
Dalton, Henry G. 41
Diehl, Ambrose N. 85
Doering, Walter C. 300
Gillies, Hugh A. 243
Glover, James 41
Hall, William B. 428
Herman, John B. 129
Hoffman, C. M. 429*
Hollingshead, Arthur G. 209, 243*
Johnson, Charles H. 243
Jones, David C. 172
Knickerbocker, Charles K. 41, 85
Lewis, Walter C. 41
McCune, C. A. 521
McGinley, Thomas A. 243*
Nash, Charles J. 209*
Pasche, Charles 40
Purdy, Frank A. 209
Robertson, William E. 129*
Rotten, Max 521
Rowan, Charles A. 428*
Rugg, Walter S. 243
Smith, D. M. 428
Smith, Gerard L. 209
Spengler, George E. 429
Thompson, William D. 521
Timken, H. H. 521*
Van Sweringen, George N. 428*
Vauclain, Samuel Matthews 129*
Whipple, Abram Ladue 428*
Wolff, Herbert W. 377*
Wright, C. S. 335
Wright, William Van Doren 521
Wyler, Paul 243

* Indicates photograph.

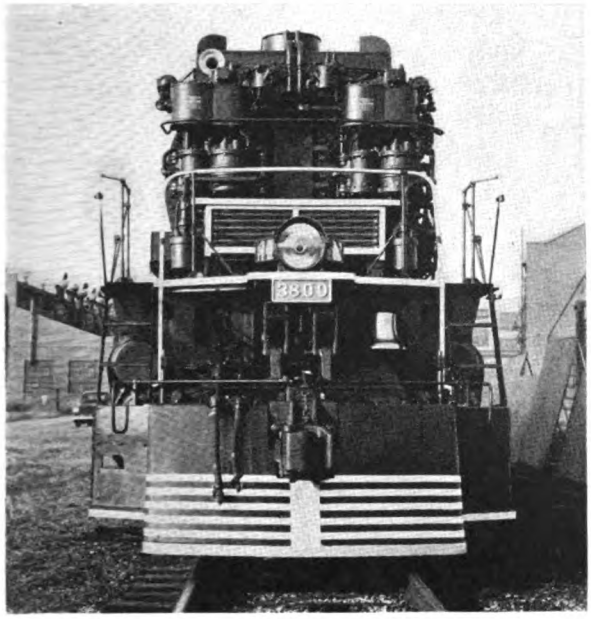
The inclusive page numbers of each 1940 issue of the *Railway Mechanical Engineer* are as follows:

January 1- 42
February 43- 86
March 87-130
April 131-174
May 175-210
June 211-244
July 245-302
August 303-336
September 337-378
October 379-430
November 431-522
December 523-560

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See page 1

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January, 1940

Volume 114 *No. 1*

Locomotive:

Twelve Coal-Burning 2-8-8-4 Locomotives for the S. P... 1

Car:

D. & H. Lightweight Coaches 8

General:

Low-Water Alarm With Two Warning Whistles 7
"City of San Francisco" Wreck 13
Designing for High-Tensile Steels 15

Editorials:

"City of San Francisco" Wreck Report 21
Steam and Diesel Locomotive Comparisons 22
Should Old Cars Be Modernized? 22
Fifteen Years of Diesel Progress 23
New Books 23

Backshop and Enginehouse:

Two Safety Features in Rod Design 24
About Press Fits 25
Locomotive Boiler Questions and Answers 25
Boiler Patch Applied to Back Head 26
Automatic Blow-Off System 26
Spray Gun for Decorative Finishing 27
Whiting Drop Pit Table 27

Car Foremen and Inspectors:

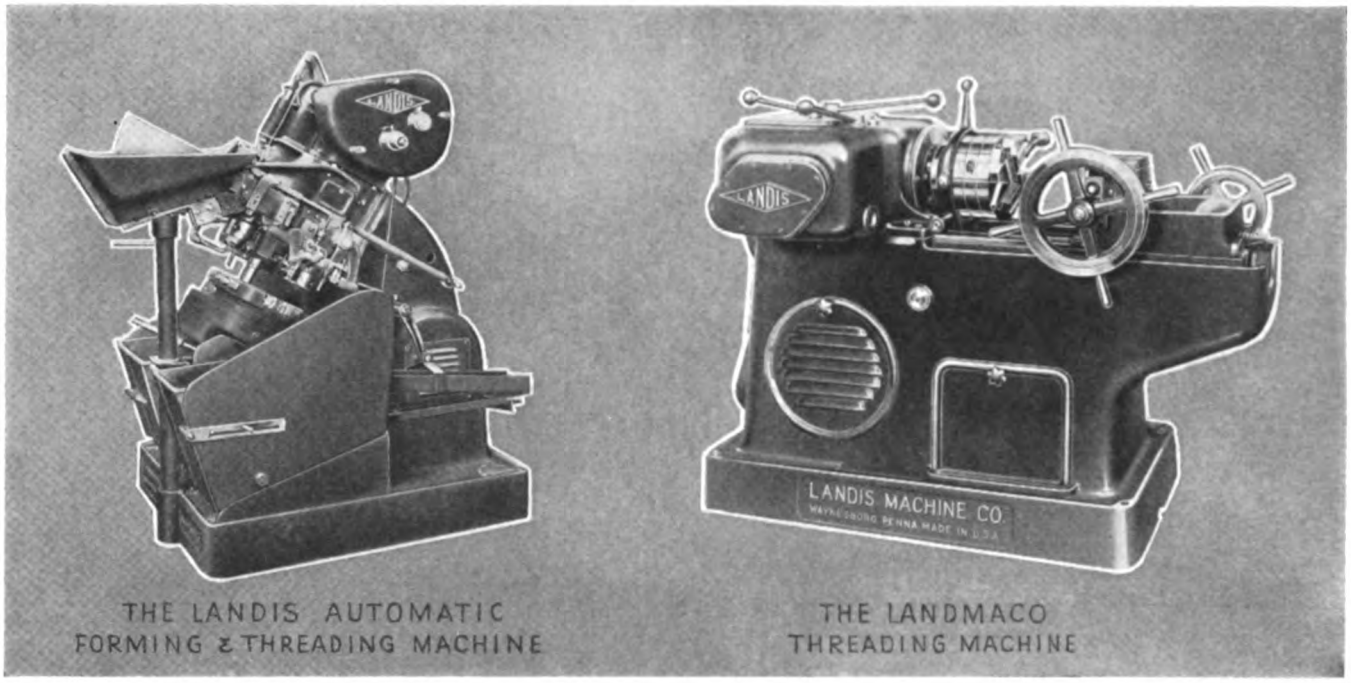
Centralia Car Shop Kinks 28
Air Brake Questions and Answers 33
Arbitration Decisions 35
Weld Recorder Indicates Defective Welds 35

High Spots in Railway Affairs 36

News 37

Index to Advertisers ..... (Adv. Sec.) 42

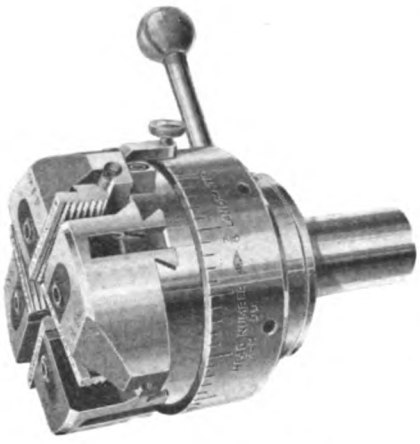
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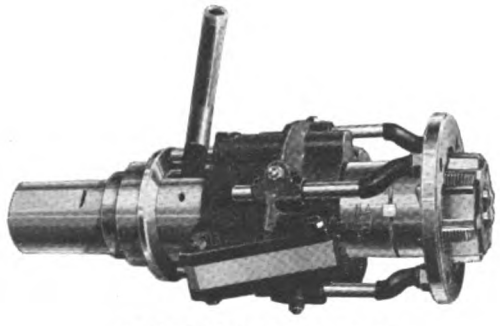


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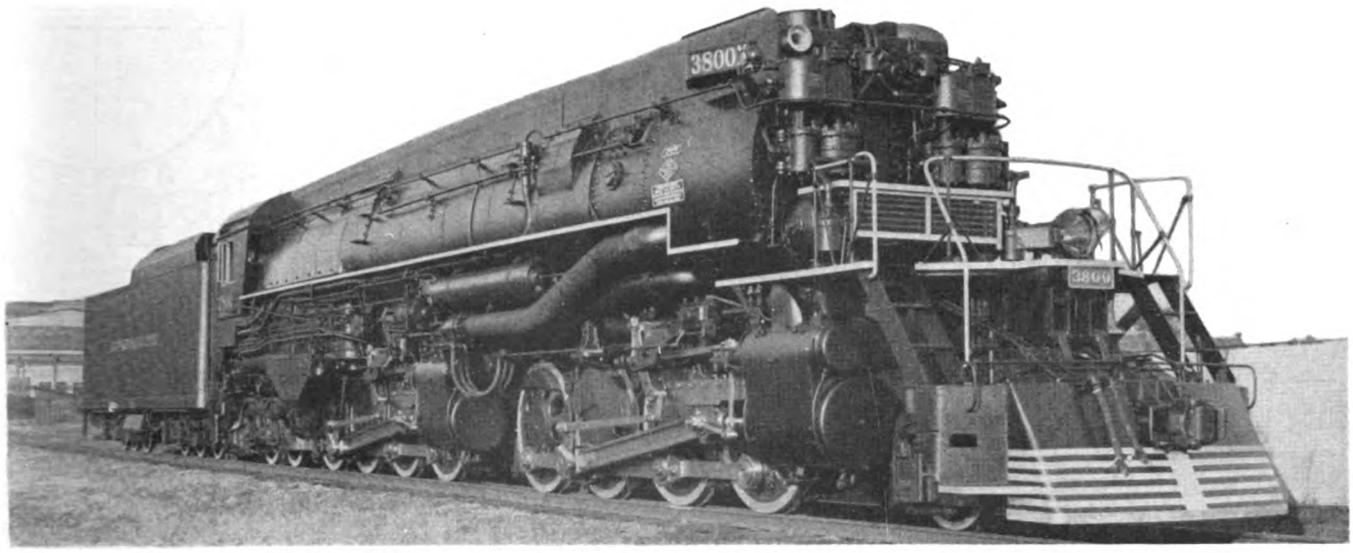
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Twelve Coal-Burning

2-8-8-4 Locomotives for S. P.

These locomotives, built by Lima, are similar in capacity to the oil-burning locomotives which operate cab ahead—They are in heavy passenger and freight service between El Paso Tex., and Tucumcari, N. M.

TWELVE articulated locomotives of the 2-8-8-4 type for passenger and freight service have been delivered by the Lima Locomotive Works, Inc., to the Southern Pacific. These locomotives are coal burners and have been given a particularly clean appearance by the use of the "skyline" casing over the top of the boiler and by a reinforced steel-plate pilot with decorative metal striping. They are in service on the Pacific Lines between El Paso, Tex., and Tucumcari, N. M. This line, which is 332 miles long, reaches a maximum elevation of 6,724 ft., with long ascents in both directions, with maximum grades of 1 per cent. Eastbound, from El Paso to the summit between Gallinas, N. M., and Corona, the line rises 3,000 ft. Westbound, between Tucumcari and the summit, the rise is 2,700 ft.

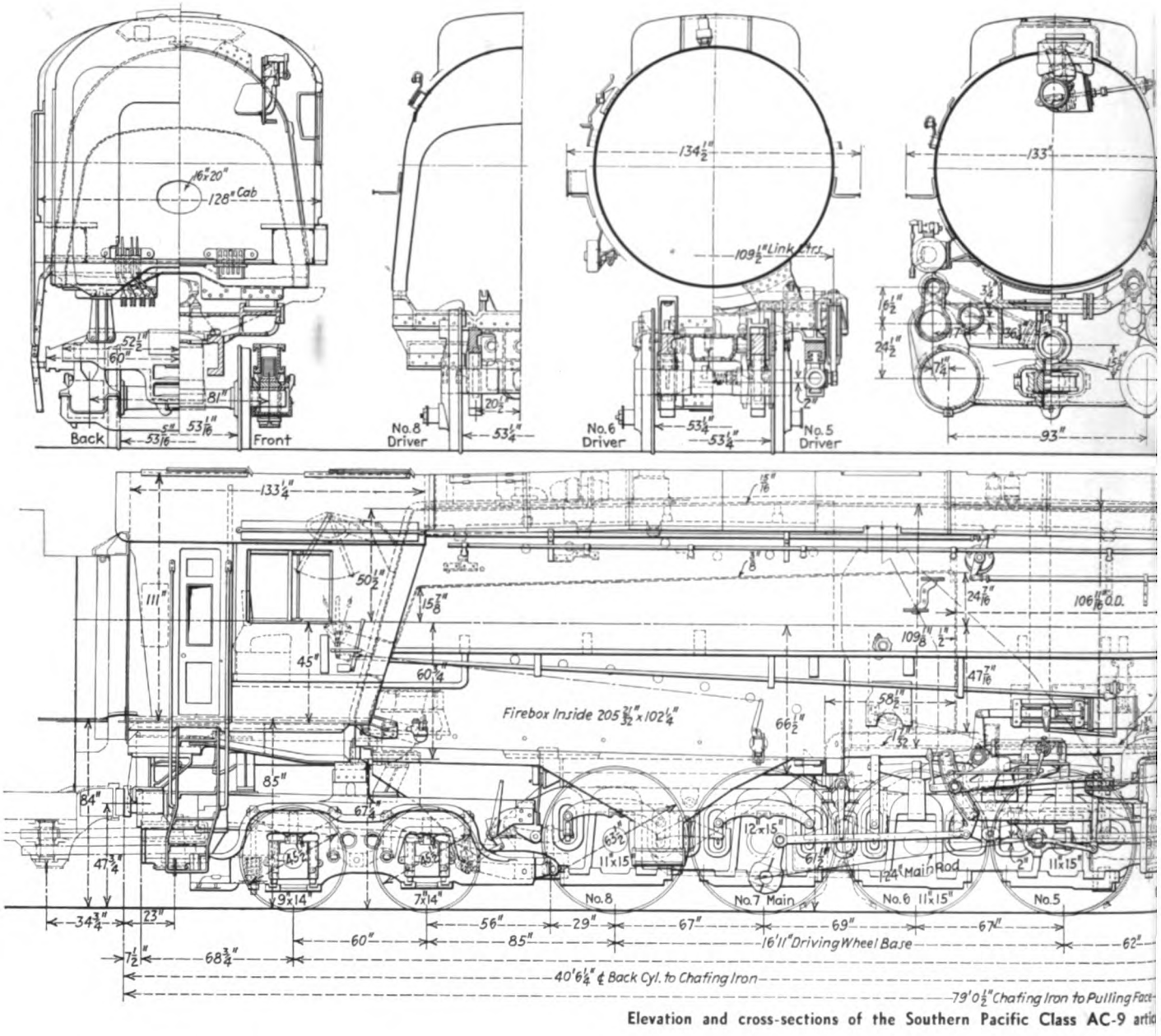
These locomotives are much the same in capacity and general construction as the locomotives of similar wheel arrangement which, since 1928, have been built in considerable numbers for oil-burning service on the Southern Pacific. The latter locomotives, however, have all been arranged for operation with the cab ahead. The boilers of the coal-burning locomotives, differing in detail dimensions from those of the oil-burning locomotives, are slightly larger. A feature of particular interest is the employment of crown-bearing driving boxes which have oil lubrication.

The locomotives have a total weight of 689,900 lb., of which 77 per cent is on the drivers, and develop a rated tractive force of 124,300 lb. The boiler carries a working pressure of 250 lb. per sq. in. The cylinders on each of the two engine units per locomotive are 24 in. bore by 32 in. stroke. The diameter of the driving wheels is 63½ in. The locomotives are designed for a maximum speed of 75 miles an hour and can negotiate curves up to a maximum of 18 deg. A maximum cylinder horsepower of 6,000 is developed at 40 m.p.h.

Frames and Running Gear

The foundation of each unit of the locomotive is a Commonwealth bed casting in which the cylinders are cast integral. The cylinder spread is 93 in. The second barrel course of the boiler is carried on the rear cylinder saddle. The front and intermediate furnace bearers are of the expansion plate type. The rear furnace bearers are oil-lubricated expansion shoes.

The hinged radius bar at the rear end of the front bed casting is pivoted about a 7-in. pin and ball joint which is pocketed in the rear cylinder saddle. The boiler bearing on the front unit is between the second and third pairs of drivers. The sliding pads are oil lu-



Elevation and cross-sections of the Southern Pacific Class AC-9 arti

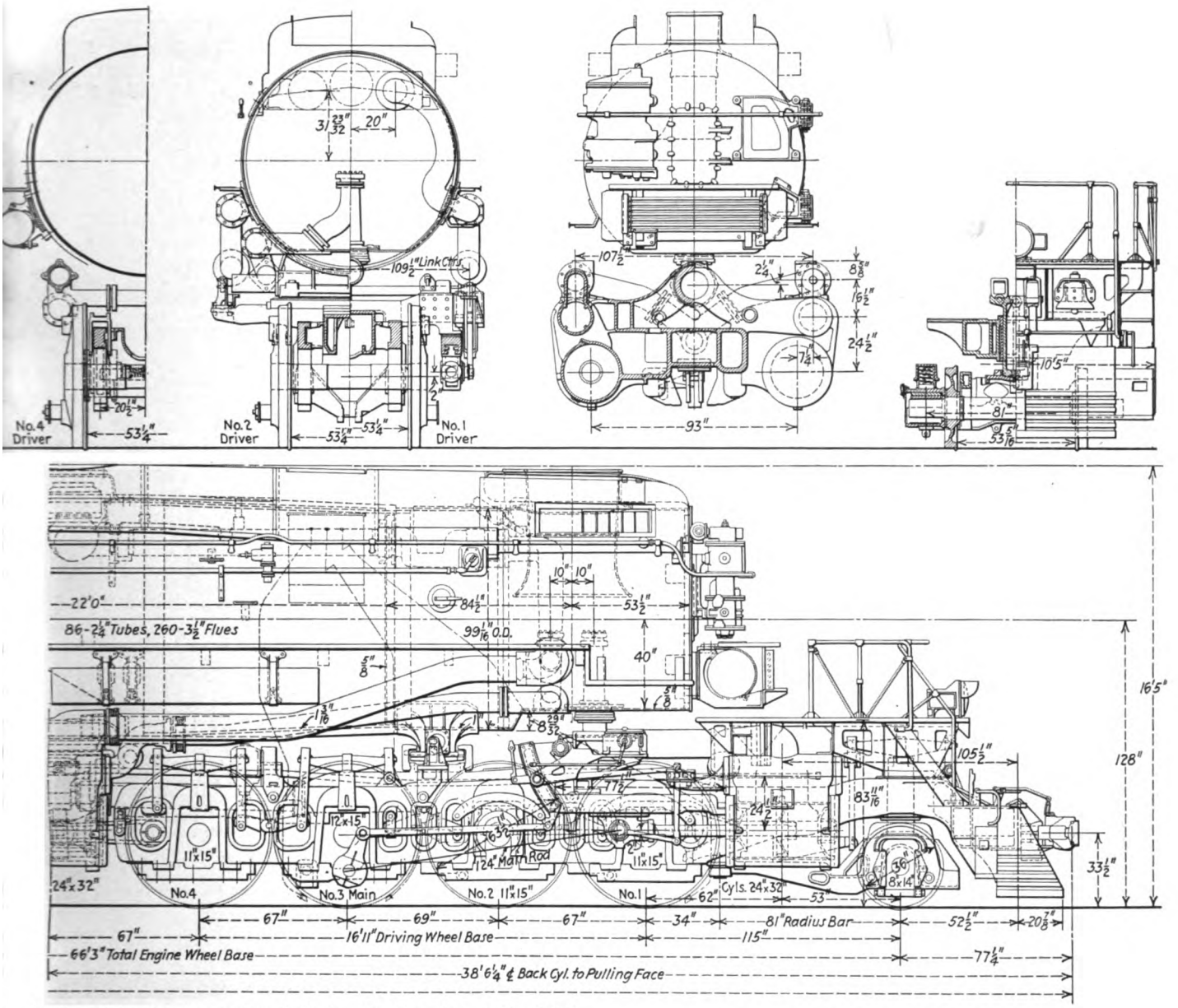
bricated and a spring centering device is part of the installation.

The driving-journal boxes are of the crown-bearing type, oil lubricated. Each driving box is provided with a spring-pad lubricator developed by the Southern Pacific which fits in the bottom of the journal-box cellar. The cellar is filled to the proper level with oil which is fed by means of cotton-string wicks to the lubricator pad that fits snugly against the bottom of the driving journal. A glass bulls-eye in the cellar shows the oil level. Supplementing the spring-pad lubrication, oil is also fed to the journals by a force-feed mechanical lubricator.

Inserted in the ends of the cellars adjoining the driving-wheel hubs are hard felt pads which project ⅛ in. beyond the Satco-lined face of the driving box. These pads are fed with oil from the cellar through small holes at the end of the cellar, thus providing positive automatic lubrication of the driving wheel hubs. The driving box cellars are held in place by latches fitted with coil springs to permit free endwise movement of the cellars when the lateral motion of the wheels causes the hub faces to come in contact with the felt pads. The cellars are easily withdrawn by sliding out the cellar endwise without removing the cellar bolts. Dirt, water, and other foreign matter is kept out of the cellars by means of serrated brass spring-action dust guards closely fitted to the top and bottom of the journals on the inside end and by a spring-action Corprene oil seal at the outside or hub end.

Because brass crown bearings do not provide a satisfactory bearing surface against steel when oil lubricated, a serrated recess is cut in the crown brass, into which is poured a lining of white metal as a bearing surface. This metal has the characteristic of maintaining an even distribution of oil over its entire surface and is soft enough so that scoring of the journals is substantially minimized should bearings become overheated for any reason. The composition of the white metal is 85 per cent tin, 10 per cent antimony, and 5 per cent copper. Satco metal is cast on the hub faces of the driving- and trailing-truck boxes.

The time required to repack the conventional grease cellars in 16 driving boxes on one of these locomotives was found to have been about 2 hrs. 40 min. The filling of 16 oil cellars in the driving boxes of one of



lated coal-burning locomotives built by the Lima Locomotive Works

these locomotives may now be accomplished in 15 min.

The driving-wheel centers are of the Boxpok type. The axle wheel fits on these locomotives are tapered 0.003 in. in diameter, the large end being at the inner end of the fit. One and one-half inches at the inner end of the fit on the axle is finished by grinding. The same principle is applied on the crank-pin fit in the wheels. The tires on the drivers and trailing wheels are protected by retaining clips, a safety feature developed by the railroad. The Alco lateral-motion device is applied on the rear pair of driving wheels on the front unit and on the front pair of driving wheels on the rear unit.

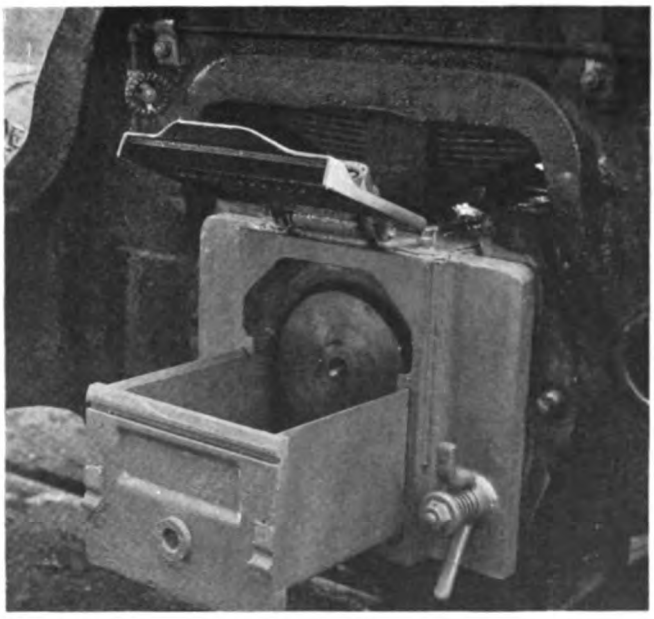
The leading truck is of the two-wheel type with a constant-resistance lateral motion of 33½ per cent. The trailing truck is of the four-wheel Delta type. The initial lateral resistance is 15 per cent with a constant-resistance of 10 per cent. Both trucks are furnished by the General Steel Castings Corporation. The leading truck wheels are of wrought steel, 36 in. in diameter. All four trailing-truck wheels have cast-steel spoke centers and are 45½ in. in diameter over the tires. The engine-truck journal bearings are 8 in. in diameter by 14 in. in length. The front bearings on the trailing trucks are 7 in. by 14 in., and the rear bearings 9 in. by 14 in.

The journal boxes on both of these trucks are fitted with the Magnus self-cooling tube type brasses lined with Satco metal. All have oil lubrication of the same type used on the driving boxes. There is, however, no force-feed lubrication to these journals.

Coil snubber springs are provided at the back end of the trailing-truck equalizing system to stabilize the rigging.

These locomotives have 40 per cent of the reciprocating parts balanced, the main wheels being cross-balanced. The balances in the front, intermediate, and back wheels are increased to allow for cross-balance effects, the overbalancing thus gained being deducted from the main wheels. The main rods were pendulum tested to determine the correct revolving effect.

The driving tires, as well as the tender wheels, are cooled with an air-controlled water system developed by the Southern Pacific. This wheel-cooling system operates automatically whenever the brakes are applied. It consists of an outlet from the water tank, operated



Trailing-truck journal box showing how the oil cellar is removed—The same type of oil lubrication is applied to the driving boxes

by an air-controlled valve with longitudinal pipes and lateral branches at each wheel, terminating in spraying nozzles. Whenever the engineman applies the brakes, he also opens the control valve of the wheel-cooling system, thus causing a sufficient amount of water to flow on the wheels to counteract the heating effect of the brake shoes. A cock conveniently located in the cab permits the engineman to cut out the cooling system when it is not needed.

The Boilers

The boilers of these locomotives are of the conical type, the taper being in the first course. The shell sheets, which are of basic open-hearth flange steel, are $1\frac{3}{16}$ in. thick in the first and second courses and $1\frac{7}{32}$ in. thick in the third course. The combustion chamber extends into the third barrel course and is $58\frac{1}{2}$ in. long. The length over the tube sheets is 22 feet.

The firebox, which measures nearly 206 in. in length inside the mud ring, is of acid open-hearth steel. It is of welded construction, with the exception of the tube sheet which is riveted in the combustion chamber. The sheets are also welded at the mud-ring corners. The longitudinal seams in the barrel courses are seal welded at the ends for a distance of about 14 in. In the firebox are seven Security circulators.

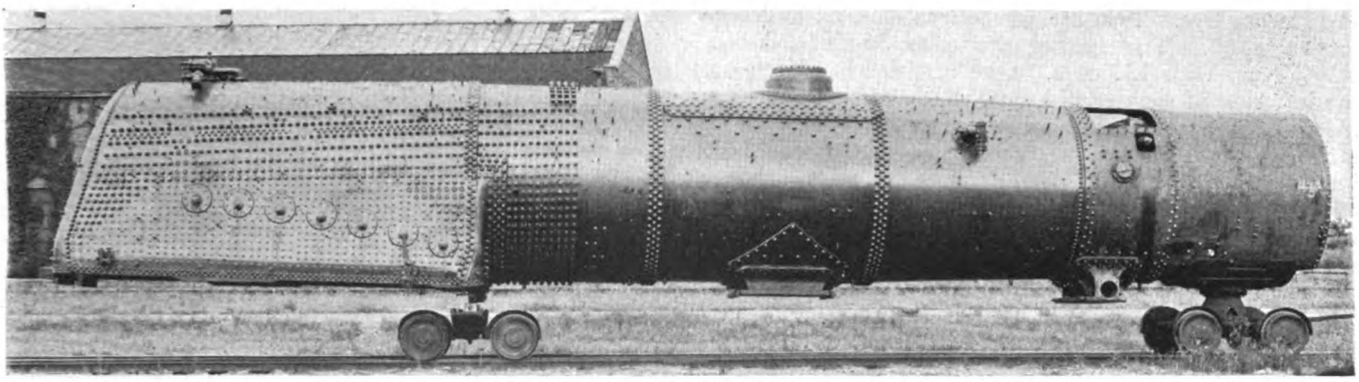
Six Nathan boiler drop plugs are placed in the crown sheet of the combustion chamber to prevent boiler explosions caused by overheating due to low water. One each is installed near the front and rear of the combustion chamber on the top longitudinal center line with two pairs placed at intermediate points, each pair spaced four rows apart on either side of the center line. The reliability and effectiveness of a multiple application of drop plugs has been demonstrated beyond question in actual service since its adoption as standard on all locomotives operated by the Southern Pacific.

Flannery Type D tell-tale flexible staybolts with UW type sleeves and caps are used in the breaking zones in the sides and back of the firebox. There is a full installation of these bolts in the combustion chamber, except for the long stays over the crown sheets. Expansion crown stays are applied on the four front transverse rows over the top of the combustion chamber. These are the Flannery Type K with WR sleeves.

The grates are the Firebar type with 21 per cent air openings, and coal is fed by a Standard type MB stoker, with the engine located in a pocket on the left side of the tender. The locomotives burn a low grade bituminous coal from the Dawson field in New Mexico. It has a heating value of approximately 12,000 B.t.u. per pound.

General Dimensions, Weights and Proportions of the Southern Pacific 2-8-8-4 Type Locomotive

Railroad	Southern Pacific
Builder	Lima Locomotive Works, Inc.
Type of locomotive	2-8-8-4
Road class	3800-3811
Road numbers	AC-9
Date built	1939
Service	Freight and passenger
Dimensions:	
Height to top of stack, ft.-in.	16-3 1/32
Height to center of boiler, ft.-in.	10-8
Width overall, in.	134½
Cylinder centers, in.	93
Weights in working order, lb.:	
On drivers:	
Front	265,500
Back	265,700
Total	531,200
Engine truck	48,300
Front trailer axle	48,900
Rear trailer axle	61,500
Total engine	689,900
Tender	400,700
Wheel bases, ft.-in.:	
Driving (each unit)	16-11
Rigid (each unit)	11-4
Engine, total	66-3
Engine and tender, total	112-11⅜
Wheels, diameter outside tires, in.:	
Driving	63½
Front truck	36
Trailing truck	45½
Engine:	
Cylinders, number, diameter and stroke, in.	4-24x32
Valve gear, type	Walschaert
Valves, piston type, size, in	11
Maximum travel, in.	6½
Steam lap, in.	1 9/16
Exhaust clearance	Line and line
Lead, in.	3/16
Cut-off in full gear, per cent	81
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	250
Diameter, first ring outside, in.	97 1/16
Diameter, largest, outside, in.	109⅛
Firebox length, in.	205 27/32
Firebox width, in.	102¼
Combustion chamber length, in.	58½
Tubes, number and diameter, in.	86 –2¼
Flues, number and diameter, in.	260—3½
Length over tube sheets, ft.-in.	22—0
Net gas area through tubes and flues, sq. ft.	12.60
Fuel	Soft coal
Grate area, sq. ft.	139.3
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	465
Circulator	124
Firebox, total	589
Tubes and flues	6,329
Evaporative, total	6,918
Superheater	2,831
Combined evap. and superheat.	9,749
Tender:	
Type	Rectangular
Water capacity, gal.	22,120
Fuel capacity, tons	28
Trucks	6-wheel
Rated tractive force, engine, lb.	124,300
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	77.00
Weight on drivers ÷ tractive force	4.27
Weight of engine ÷ evap. htg. surface	99.7
Weight of engine ÷ comb. htg. surface	70.77
Boiler proportions:	
Firebox htg. surface, per cent comb. htg. surface	6.04
Tube-flue htg. surface, per cent comb. htg. surface	64.92
Superheater htg. surface per cent comb. htg. surface	29.04
Firebox htg. surface ÷ grate area	4.23
Tube-flue htg. surface ÷ grate area	45.43
Superheater htg. surface ÷ grate area	20.32
Comb. htg. surface ÷ grate area	70.0
Gas area, tubes-flues ÷ grate area	.090
Evap. htg. surface ÷ grate area	49.66
Tractive force ÷ grate area	892.3
Tractive force ÷ evap. htg. surface	17.97
Tractive force ÷ comb. htg. surface	12.75
Tractive force × dia. drivers ÷ comb. htg. surface	809.6



The boiler is supported by sliding shoes under the rear end of the firebox, by expansion plate under the front end of the firebox, by the rear cylinder saddle under the middle barrel course, and by sliding pad under the rear of the smokebox

The boiler feed equipment comprises a Hancock turbo feedwater heater, size TA-2, mounted below the cab on the left side of the locomotive, which is capable of delivering to the boiler 13,000 gallons of water per hour. Supplementing the feedwater heater is a Nathan No. 17 Simplex injector with a rating of 12,000 gallons per hour. The Signal Foam-Meter and Electro-Pneumatic blow-off are part of the boiler equipment.

The superheater is a Type E with the American multiple throttle built into the header. Steam enters the drypipe through a Tangential steam dryer in the dome.

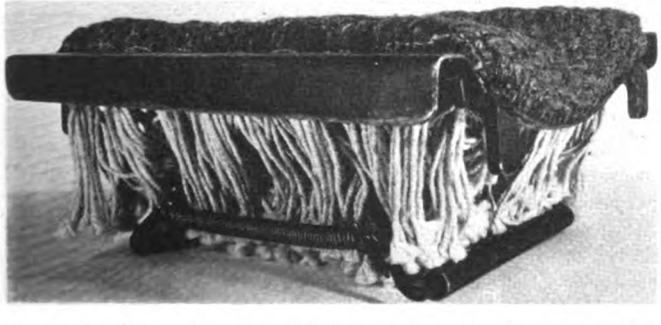
The ash pans are designed with an air opening equal to the total flue cross-sectional area. In addition to the two hoppers inside the frames, there is an outside hopper at the front of the ash pan on either side of the locomotive.

Steam Distribution

Steam for both engines leaves the front-end branch pipes through a single pair of outside steam pipes, one on each side of the locomotive. Each of these pipes, which are 9 in. in diameter, is carried back from the elbow casting at the side of the smokebox to the front of the rear cylinders where there is a slip-joint connection. Live steam for the front pair of cylinders is carried forward from the front face of the rear saddle casting by a single 8-in. pipe on the longitudinal center line of the locomotive. This pipe is in two sections with ball and slip joints between the sections and a ball joint at the back hinge connection. The connection between the sections is made in a chamber in the bed casting. The steam pipes are insulated with special Insubestos covering.

Exhaust pipes from the rear cylinders extend forward along each side of the locomotive toward the smokebox. These are 8-in. pipes with slip joints between the pipes and cast-steel extensions from the cylinders. These extensions are cross-connected to supply steam to the turbo feedwater heater. At the smokebox end, the exhaust-pipe flange is bolted to a smokebox elbow connection leading to the rear of two exhaust pipes. The flexible exhaust pipe from the front cylinders is made up of two sections of cast-iron pipe which are joined by a long slip joint. The front section is fastened to the cylinder-saddle casting by a ball joint, and the elbow at the rear end of the rear section has a ball seat in a spring casing attached to a bolting flange at the bottom of the smokebox. This forms the base of the forward exhaust stand. The exhaust pipes are not lagged.

Steam distribution is effected by Walschaert valve motion which drives 11-in. valves with a maximum travel of 6½ in. The power reverse gear is an Alco type H. The valves are fitted with Hunt-Spiller gun-iron bull rings and Duplex sectional packing rings. The valve-chamber bushings are also of Hunt-Spiller gun iron.



The driving-box spring-pad lubricator used on the Southern Pacific locomotives

The Driving Gear

The main driving wheels are the third pair in each engine unit. The side rods have fixed bronze crankpin bearings on the first and fourth pairs of driving wheels and floating bushings on the main and intermediate crank pins. The floating bronze bushings run in Hunt-Spiller gun-iron fixed bushings. The back end of the main rod also has a floating-bushing bearing. Bronze wear plates are set in the faces of the main and intermediate driving wheels around the crank pins on both engine units to prevent wear of the ends of the fixed rod bushings.

The guides and crossheads are of the multiple-bearing type. The crossheads are cast steel and bronze rings inside prevent galling of the front end of the main rod. The pistons are the Locomotive Finished Material Company's lightweight alloy-steel type with combination bronze and iron packing rings.

The main and side rods, the driving axles, engine and trailer-truck axles, crank pins, wrist pins, knuckle pins, combination lever, union link, and radius-bar lifter are all of medium carbon steel normalized and drawn. The driving axles are hollow bored to a diameter of 3 in. The valve-motion eccentric crank is also of medium carbon steel while the eccentric rod and link cheeks are of mild carbon steel. The link blocks are of mild steel, casehardened. Carbon-vanadium steel is used in the main and valve-stem crosshead keys. The guides are medium carbon steel, annealed.

Lubrication

There are four force-feed mechanical lubricators on

each locomotive. Two are for journal-box oil and two for valve oil. The former are each 36-pint Nathan DV-7 type, with 13 feeds. One of these is placed on the left side of each engine unit where it can be driven from the link of the valve motion. Eight feeds from each of these lubricators are used for driving-box journal lubrication, one feed leading to each driving box on the unit. Each of four feeds leads to a Nathan four-way oil distributor which serves the shoe and wedge faces for each pair of driving boxes. One feed, through a four-way distributor, lubricates the valve-rod crosshead guides. Texayce all-year car oil, conforming to Southern Pacific specifications, is used in these lubricators and in the cellars of all driving, engine-, trailer- and tender-truck boxes for journal lubrication.

A 20-pint Nathan DV-4 eight-feed mechanical lubricator is mounted on the right side of each engine unit. Feeds from these lubricators lead to the cylinders and steam chests. There are two feeds for the top of each main guide.

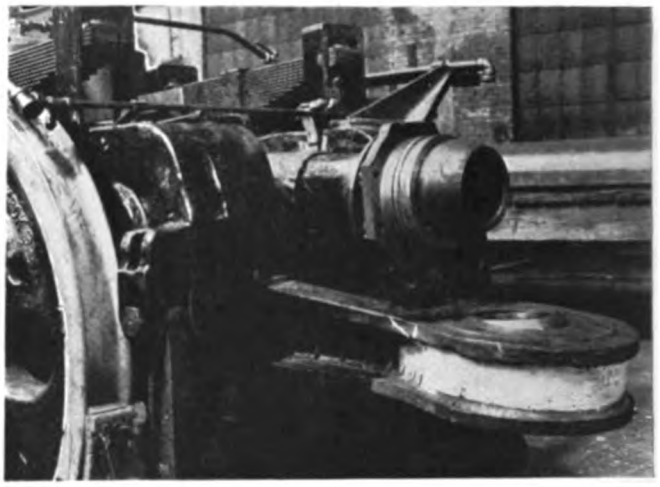
Fittings for Alemite lubrication are applied on the power reverse gear, the radial buffer, the side-rod knuckle pins, and the valve-motion parts. All crank pins and the eccentric-crank pins and rods are internally pressure-grease lubricated, and the rod ends are forged without grease cavities.

Cab and Cab Equipment

The steel cab is vestibuled and insulated below the windows. On six of the locomotives the insulation is 2 in. of Fiberglass and on the other six, Hairinsul. The cab windows are closed with Plexite non-shatter glass about 9/16 in. thick in the front windows and ⅜ in. thick in the sides and back. There is a seat and window for the head brakeman at the rear of the cab on the left side. All three cab seats have Dunlopillo sponge-rubber cushions and back rests.

There is a combination cab turret for both superheated and saturated steam. The superheated-steam section of the turret serves the blower, the stoker, the stoker engine, the stoker jets, and the soot blower. An auxiliary turret on the left side of the smokebox, through which the cab turret is supplied, also supplies superheated steam for the air compressors and the steam whistle. There is an air horn in addition to the steam whistle.

The air-brake equipment is Westinghouse No. 8ET.



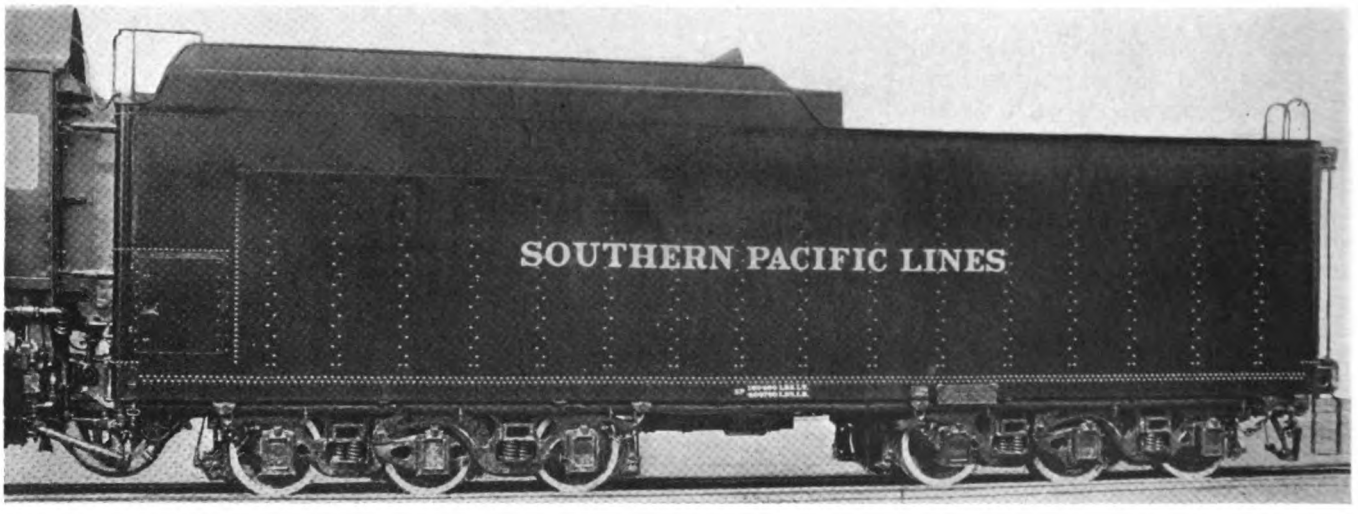
The rear end of the front bed casting and running gear—In the foreground are the radius bar and the ball joint on the rear end of the steam pipe to the front cylinders

Two 8½-in. cross-compound air compressors are mounted on the smokebox front. A Westinghouse air intercooler is placed ahead of the smokebox.

These locomotives are equipped with both the Valve Pilot and steamchest and back-pressure gages operating on the rear engine only.

The Tender

The tender has a fuel and water capacity of 28 tons and 22,120 gallons, respectively. It is built up on a General Steel Castings water-bottom underframe. The tank sheets are welded to the underframe at the bottom. The remainder of the structure, however, is fabricated by riveting. In the coal space is a Standard type DA coal pusher.



The tender tank is of riveted construction

The two Buckeye six-wheel trucks are carried on 36-in. wrought-steel wheels with journals 7 in. in diameter by 14 in. long. The journal boxes are equipped with the Magnus self-cooling tube-type brasses lined with Satco metal, and the cellars are fitted with spring-pad lubricators similar to those in the locomotive driving and truck boxes. The wheel base of the trucks is 10 ft. The A. S. F. clasp brakes are operated by two 16-in. body-mounted cylinders. The engine and tender coupl-

ing includes the unit draw and safety bars and Franklin E-2 type buffer.

The boiler jacket, the skyline casing, the outside of the cab, except the roof, and the outside of the tender are finished in lacquer.

The principal dimensions and data are shown in one of the tables.

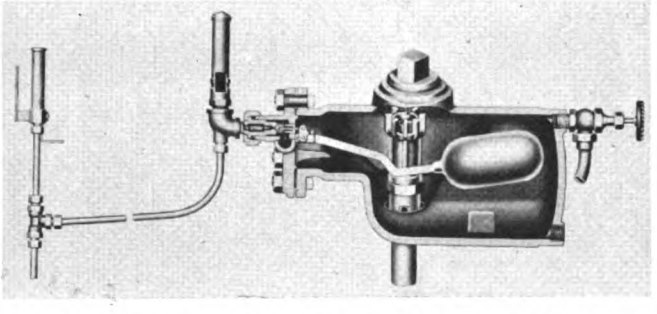
Partial List of Materials and Equipment on the Southern Pacific 2-8-8-4 Type Locomotive Built by Lima Locomotive Works

Bed castings; engine and trailer trucks	General Steel Castings Corp., Eddystone, Pa.
Axles, engine-truck wheels, tires, main crank pins	Standard Steel Works Co., Burnham, Pa.
Driving-wheel centers (Boxpok); trailing-wheel centers; crossheads; cylinder heads; driving boxes; smokestack	Ohio Steel Foundry Co., Lima, Ohio
Driving and truck-box bearings; bronze shoes and wedges	Magnus Metal Div., National Lead Co., New York
Tire retaining clips	Southern Pacific
Springs	American Locomotive Co., Railway Steel Spring Div., New York
Lateral motion device	American Locomotive Co., New York
Coupler and front draw casting	National Malleable and Steel Castings Co., Cleveland, Ohio
Journal-box lids, engine-truck and trailer	The Symington-Gould Corp., Rochester, N. Y.
Spring type radial buffer	Franklin Railway Supply Co., Inc., New York
Air-brake equipment	Westinghouse Air Brake Co., Wilmerding, Pa.
Driver brake shoes	American Brake Shoe & Foundry Co., New York
Foundation brake	American Brake Co., St. Louis, Mo.
Force-feed lubricators; hydrostatic lubricators	Nathan Manufacturing Co., New York
Hose, chassis lubrication	The DeVilbiss Company, Toledo, Ohio
Lubrication, soft grease	The Prime Manufacturing Co., Milwaukee, Wis.
Copper tubing	Phelps Dodge Copper Products Corp., New York
Flexible conduit on force-feed lubricator steam line	Barco Manufacturing Co., Chicago
Guides and piston-rod steel	Pittsburgh Crucible Steel Co., Pittsburgh, Pa.
Pistons	Locomotive Finished Material Co., Atchison, Kan.
Rod packing	Paxton-Mitchell Co., Omaha, Neb.
Valve bull rings; piston-valve bushings; rod bushings; Duplex sectional valve packing rings and springs	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Reverse gear	American Locomotive Co., New York
Staybolts, tell-tale flexible	Flannery Bolt Co., Bridgeville, Pa.
Rivets	The Champion Rivet Co., Cleveland, Ohio
Spring washers	National Lock Washer Co., Newark, N. J.
Staybolt iron	Ulster Iron Works, Dover, N. J.
Circulator units; firebrick	American Arch Co., Inc., New York
Circulator plugs	Huron Mfg. Co., Detroit, Mich.
Cylinder cocks	Southern Pacific Co.
Cylinder drain valves; smokebox front hinges	The Okadee Company, Chicago
Superheater; Tangential steam dryer; pyrometer	The Superheater Company, New York
Throttle, front-end multiple	American Throttle Co., New York
Smokebox netting	John A. Roebling's Sons Co., Trenton, N. J.
Tubes and flues (10) (2)	Jones & Laughlin Steel Corp., Pittsburgh, Pa. Pittsburgh Steel Co., Pittsburgh, Pa.
Boiler drop plugs	Nathan Manufacturing Co., New York
Firebox steel; tank steel in boiler; smokebox plates; engine bolt iron	Bethlehem Steel Co., Bethlehem, Pa.
Boiler flange steel	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Boiler braces; drawbar and safety bar; drawbar pins	Lockhart Iron & Steel Co., McKees Rocks, Pa.
Boiler lagging	Johns-Manville Sales Corp., New York
Boiler jacket	Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Cab steel plate	The Weirton Steel Co., Weirton, W. Va.
Cab insulation: Fiberglas (6) Hairinsul (6)	Gustin-Bacon Mfg. Co., Kansas City, Mo. Johns-Manville Sales Corp., New York
Cab-seat cushions	Dunlop Tire & Rubber Corp., Buffalo, N. Y.
Cab window glass	American Window Glass Co., Pittsburgh, Pa.
Window sash	Aluminum Co. of America, Pittsburgh, Pa.
Cab ventilators (side)	The Prime Manufacturing Co., Milwaukee, Wis.
Tread plate, Inland four-way	Joseph T. Ryerson & Son, Inc., Chicago
Stoker	Standard Stoker Co, Inc, New York
Grates (Firebar)	Waugh Equipment Co, New York
Ashpan plates	Otis Steel Co., Cleveland, Ohio
Soot blowers	Superior Railway Products Corp., Pittsburgh, Pa.
Firedoor; sleeve joints	Franklin Railway Supply Co., Inc., New York
Equalizer pins and bushings	Ex-Cell-O Corporation, Detroit, Mich.
Injector	Nathan Manufacturing Co., New York
Exhaust-steam turbo feed-water heater	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Steam-heat reducing valve and stop valve	Vapor Car Heating Co., Inc., Chicago
Steam gage; steam-heat gage; stoker gage; safety valve	Ashton Valve Co., Boston, Mass.
Steam-pipe covering; smokebox tape	Union Asbestos & Rubber Co., Chicago
Pipe, wrought iron	A. M. Byers Co., Pittsburgh, Pa.
Pipe unions	The Corley Co., Jersey City, N. J.
Blow-off separator and discharge muffler	Wilson Engineering Corp., Chicago
Saturated steam valves	Crane Co., Chicago
Superheated steam valves	Walworth Co., New York
Water gage	Nathan Manufacturing Co., New York
Back-pressure gage; water-level indicator	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Train indicators	The Adams & Westlake Co., Elkhart, Ind.
Signal Foam-Meter	Electro Chemical Engineering Corp., Subsidiary of Dearborn Chemical Company, Chicago
Valve Pilot	Valve Pilot Corporation, New York
Sander	Viloco Railway Equipment Co., Chicago
Automatic drain cocks	The Okadee Company, Chicago
Bell ringer	Transportation Devices Corp., Indianapolis, Ind.
Horn	The Leslie Co., Lyndhurst, N. J.
Headlight and headlight wiring fixtures	Pyle-National Co., Chicago
Headlight generator	Sunbeam Electric Mfg. Co., Evansville, Ind.
Wiring, electric	General Cable Corporation, New York
Tender:	
Frame	General Steel Castings Corp., Eddystone, Pa.
Truck	Buckeye Steel Castings Co., Columbus, Ohio
Volute spring snubbers	The Holland Co., Chicago
Wheels	Standard Steel Works Co., Burnham, Pa.
Journal-box lids	The Symington-Gould Corp., Rochester, N. Y.
Bearings	Magnus Metal Div., National Lead Co., New York
Brake shoes	American Brake Shoe & Foundry Co., New York
Clasp brakes	American Steel Foundries, Chicago
Hand brakes; draft gear	W. H. Miner, Inc., Chicago
Coupler and coupler yoke	National Malleable and Steel Castings Co., Cleveland, Ohio
Tank steel	Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Tank hose	Quaker City Rubber Co., Philadelphia, Pa.
Dust guard	MacLean-Fogg Lock Nut Co., Chicago
Coal pusher	Standard Stoker Co., New York
Lacquer (6) (6)	Pittsburgh Plate Glass Co., Pittsburgh, Pa. E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Jacks	The Duff-Norton Manufacturing Company, Pittsburgh, Pa.
Wrenches	J. H. Williams & Co., New York

Low Water Alarm with Two Warning Whistles

The familiar type of float low-water alarm, supplied by the Barco Manufacturing Company, Chicago, has recently been equipped with an additional whistle connection in the cab which gives a double alarm feature, designed to furnish adequate warning in cases of low water under all operating conditions. The large whistle at the alarm on the outside of the boiler gives warning to terminal forces when the locomotive may be on some outlying track, and the smaller whistle in the cab gives a direct indication to the engine crew when the locomotive may be working hard and the cab is closed with storm curtains, or has a vestibule construction which more or less excludes outside sounds and noises.

The provision of the second whistle, installed in the cab, is designed to assure that, under no possible operating condition, can there be an excuse for engine crews not hearing the warning signal in the cab.



Barco float low water alarm, equipped with a supplementary small whistle and drain pipe in the cab

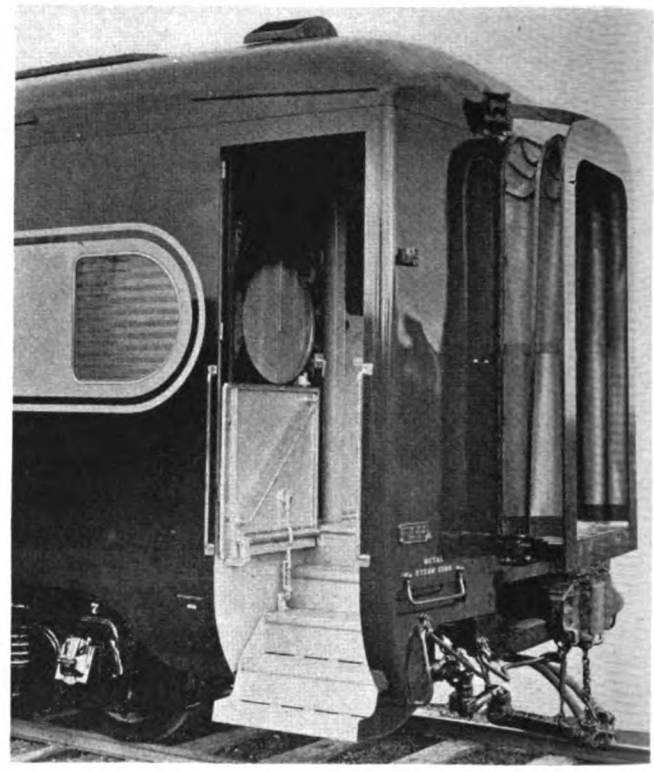
High Tensile Steel Used in Construction of

D. & H. Lightweight Coaches

WITHIN the past two months the Delaware & Hudson installed six 76-passenger coaches, of lightweight welded construction in service on important main-line trains, such as the "Laurentian," between New York and Montreal, Que. These coaches embody the use of U SS Cor-Ten and carbon steel structural shapes in the side and underframing, Armco HT50 sheets in the car sides and roof and Republic RDS pressed framing members.

The cars are designed with large vestibules at each end, equipped with folding steps. The door openings in the vestibules are 36 in. wide. The interior of the cars is arranged with a 65 ft. 1 in. passenger-carrying space with women's and men's rooms at one end of the car,



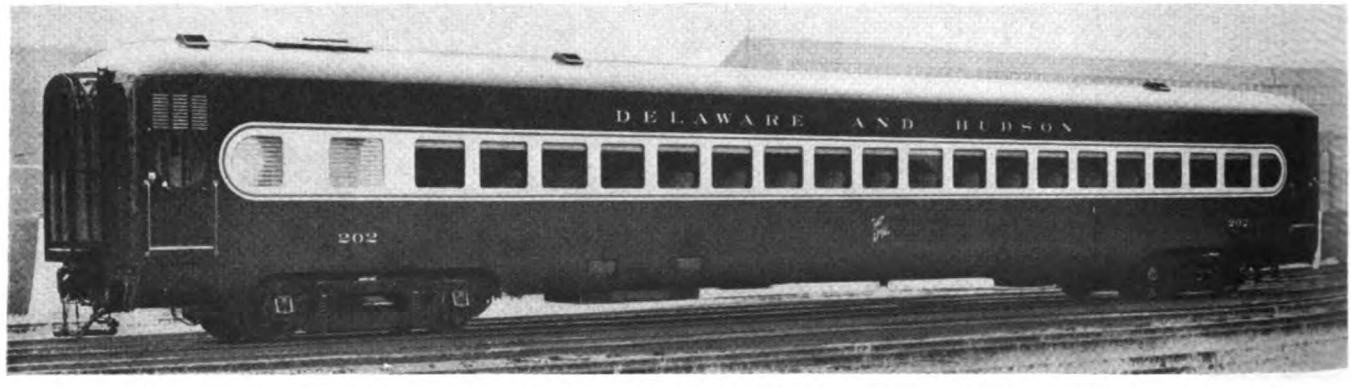


The vestibules have folding steps

together with a luggage compartment with shelves on one side of the car adjacent to the men's room. The space occupied by the latter facilities is 8 ft. 10⅞ in. The aisle width is 2 ft. 2¼ in.

Car Structure

The underframe is built up of a rolled Z-section side sill and a standard A. A. R. center sill section of open hearth steel having a 36,000 lb. per sq. in. yield point. An open hearth steel bottom cover plate is used to lower the neutral axis of the section to a point near the center line of draft. These two rolled sections are framed together with light-pressed channel floor beams which run continuously from side sill to side sill over the top



One of the lightweight coaches built for the D. & H. by American Car & Foundry Company



Interior framing and insulation

of the center sill. The cross bearers are made by dropping a web plate from the above-mentioned floor beam and adding a rolled angle bottom chord.

The bolster is of welded construction consisting of low alloy steel top and bottom cover plates which are welded to web plates of the same material. This box section is further stiffened over the side bearing by the addition of web and flange stiffeners.

Table I—Principal Weights and Dimensions of Delaware & Hudson Coaches

Length over buffers, uncoupled, ft.-in.	84-9
Length over coupler pulling faces, ft.-in.	84-3
Truck wheel-base, ft.-in.	9-0
Truck centers, ft.-in.	58-6
Width over side posts, ft.-in.	10-0
Width inside, ft.-in.	9-5⅜
Height, rail to floor, ft.-in.	4-3¾
Height, rail to top of roof, ft.-in.	13-6
Weight, light, total, lb.	112,920
Weight of one truck, without generator drive, lb.	18,140
Weight of truck with Spicer drive, lb.	18,800

Light gage steel false floor sheets were then tack-welded to the underframe members, thus forming a water-tight, fire-proof bottom covering for the floor. Z-shaped lightweight stringers are then laid longitudinally and securely fastened to both the false floor sheets and the underframe cross members. Chanarch flooring ⅝-in. in depth is fastened to these stringers with machine screws. The underframe is an arc-welded structure.

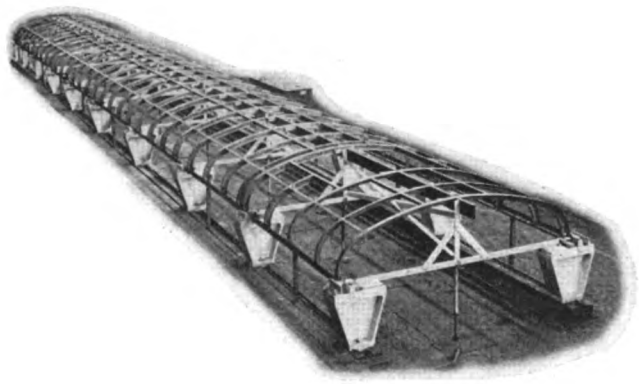
The side framing is of girder type construction with a rolled-angle side sill or bottom chord and a lightweight Z-bar rolled side plate or top chord member. The posts are a pressed flanged U-section which, when spot welded to 14-gage side sheets, make a stiff but light box section. The belt rail and window headers consist of pressed Z-shaped members, and are so fastened to the side posts that they function as continuous members.

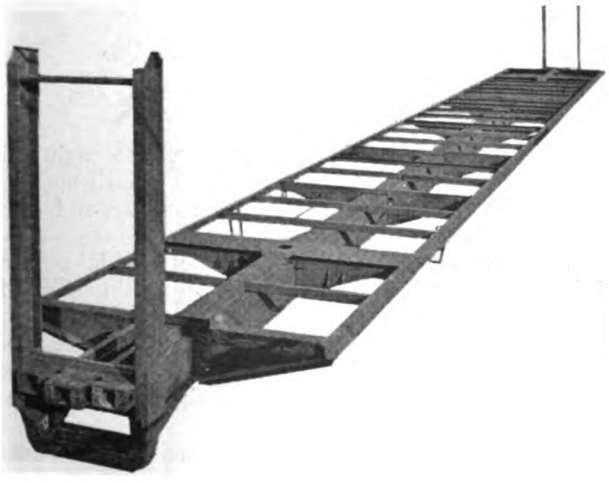
The roof framing consists of a lightweight side plate angle to which is arc welded pressed Z-shaped carlines. Four Z-shaped purlines are welded to the carlines and run the entire length of the car and when spot welded together with the carlines and the .06-in. roof sheets form a substantial and stiff unit when finally fastened to the two sides of the car shell. Further rigidity is gained by the light trussed framing which is welded to the carline to house the air-conditioning duct and support the headlining.

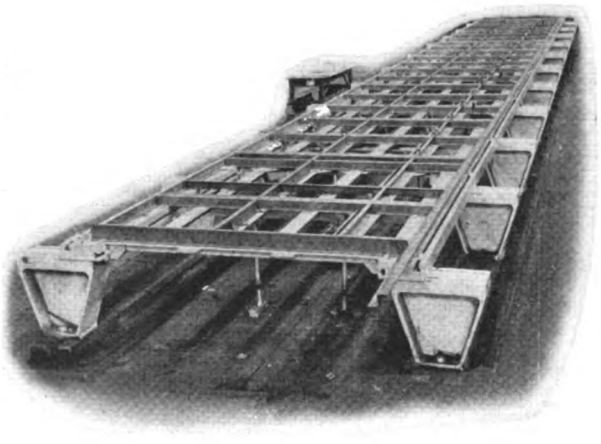
Method of Spot Welding

In fabricating the major units of these cars such as the sides, ends, and roof, the spot welding is performed by a multiple spot-welding machine. Preliminary to the spot-welding operations the side framing and roof framing is assembled in an accurate jig. In one case the post and side members are arc-welded together and, in the case of the roof, the carline and purlines are arc-welded together. The outside sheets of the side and the roof are then attached. The units, in their fitted position, are then ready to go to the spot welder.

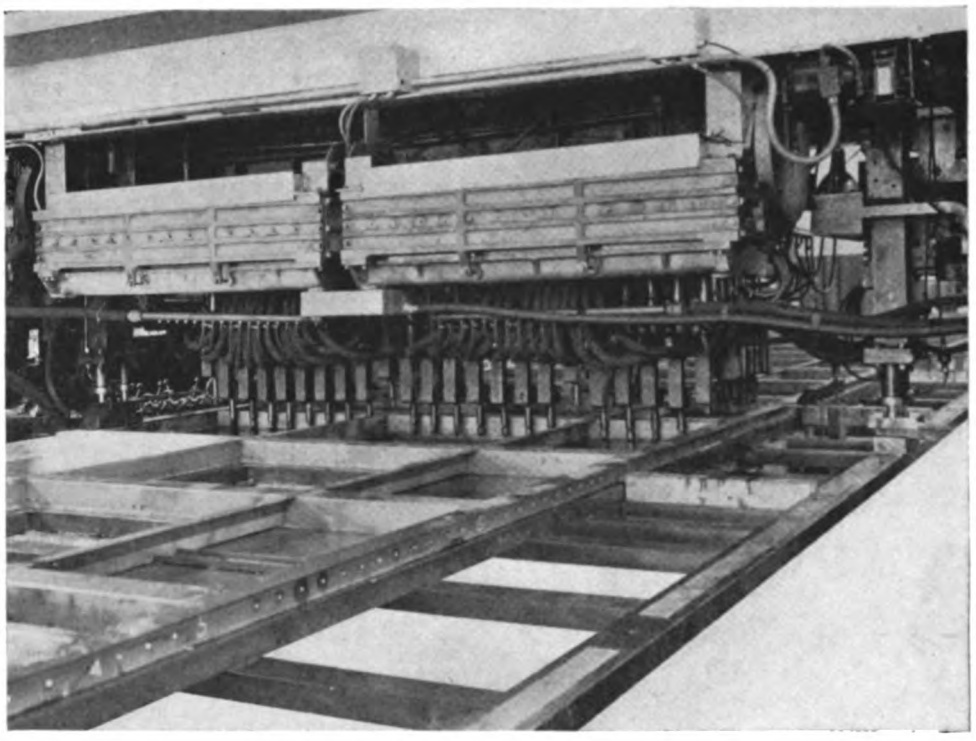
The semi-automatic welding machine consists of a platen, upon which is mounted the multiple electrode







Below, at left: The completed arc-welded underframe and end structure—USS Cor-Ten and carbon steel shapes were used—The other two views show a side frame and roof frame in jigs ready for the spot welder

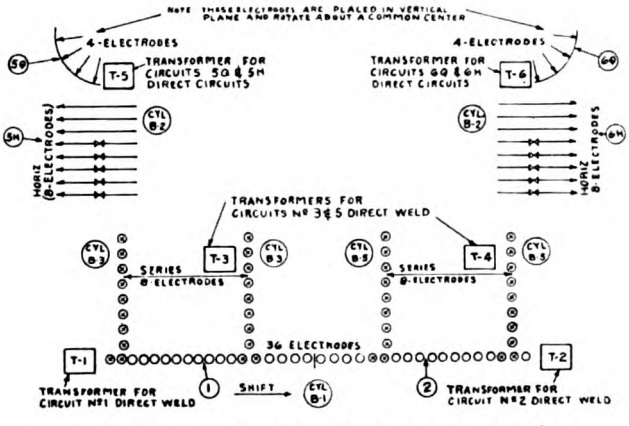


The platen and electrodes—The transformer contact shoe is seen at the right

set-up, and a transfer welding-jig car, which moves on the track under the platen. The platen of the machine is lowered vertically with its electrodes to make contact with the work. In the set-up of the electrodes, they are spaced to meet the location requirements of the design of the car. Successive panels are welded by the indexing of the jig car.

In lowering the platen to make the weld, the electrodes are under pressure simultaneously and act as a self-contained clamp at each weld location. They remain in that position through the entire cycle of the welding sequence. After the current is cut off the electrodes remain in contact as a clamp until the welds are cooled.

In the welding of a car side, the operations are performed panel by panel. The side framing units, together with the side sheets, are placed, in proper alignment, on a copper grillage which is a part of the jig car. The grillage is the secondary part of the jig-car circuit. The platen, with its electrodes, is lowered to contact the work, and, at the same time, the contact shoes of the welding transformers make contact with the bus-bar grillage. Motor-driven secondary distributing switches



Electrode set-up for flat and curved parts of roof

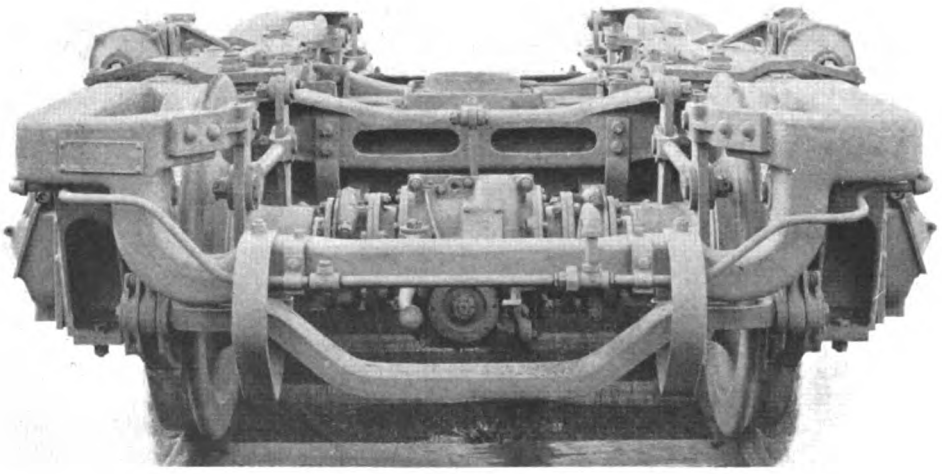


Automatic spot welder and welding jig cars

pass about 20,000 amperes successively to each welding electrode. The switches are started by a push-button control and stopped by a limit switch at the end of their travel.

The intermediate spacing of spot welds requires a 1-in. lift of the platen and a 1-in. or 2-in. shift of the electrode mounting and shifting slide. The cycle of a panel is then repeated as required to meet the spacing. When the welding of a panel is complete, the platen is raised to the limit switch and the jig car indexed to the next panel.

The movements of the welding machine units are con-



One of the trucks with the Spicer generator drive — These trucks have balanced, ground wheels, clasp brakes and weigh 18,800 lb.

trolled from a central operator's station. Any one of a dozen operations are controlled manually and individually. A dozen operations may be executed automatically as one by means of a selector switch.

The electrode set-up for welding one panel of a car side is similar to that used in welding a panel of the flat portion of a car roof. In welding a roof panel, the operations are performed in two positions. The first position (on the flat portion) utilizes 4 transformers, 4 secondary switches, and 68 electrodes arranged in four groups as shown in the lower portion of the accompanying diagram. The second position, during which the welding operations on the curved portion of the roof are performed, utilizes 2 transformers, 2 secondary switches, and 24 electrodes arranged in four groups. Two groups of four electrodes each on a quadrant complete the carline weld on the curvature. Two groups of eight electrodes each mounted horizontally take the eave angle to the roof sheets. Upon the completion of these two position operations, which complete a panel, the platen is raised to the limit switch and the jig car indexed for the next panel.

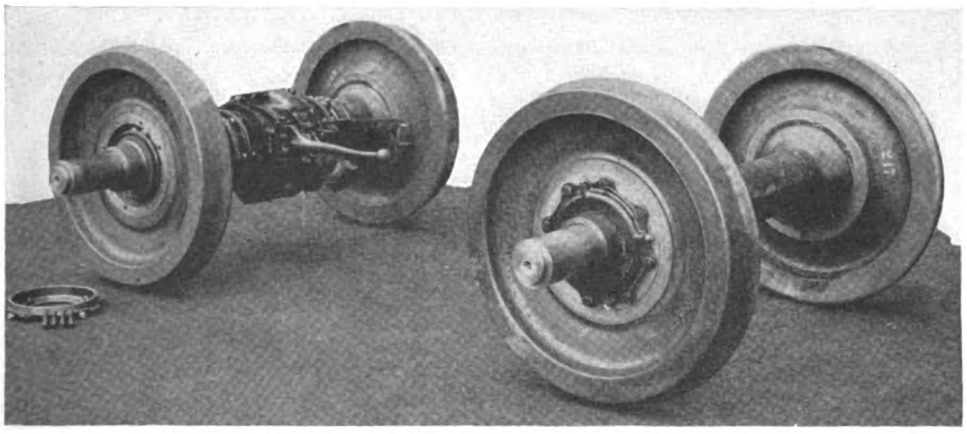
Exterior and Interior Decoration

These new coaches were styled by Raymond Loewy. The exterior is painted a dark green with a soft gray panel, accented with an orange stripe used to outline the outside window areas. Lettering, numbering and the railroad company monogram are all done in golden yellow.

For the interiors of the six coaches, three alternate color schemes have been chosen; the architectural and design features are similar. For instance, in all the coaches the end seats in each car have been given an

Table II—Color Schemes for Interiors

Location	No. 1	No. 2	No. 3
Ceiling	Pale yellow	Pale yellow	Sun tan
Bulkhead panels	Silver opalescence and moss green	Silver opalescence and delft blue	Rose opalescence and apple green
Walls, pier panels, dado and Pantasote curtains	Various tones and shades of moss green	Various tones and shades of delft blue	Various tones and shades of apple green
Seats	Soft gray and cedar rose	Soft gray and cedar rose	Mahogany rose and Moorish green
Colors accents	Red and yellow	Dusty rose	Yellow and autumn red
Flooring	Sand jaspe with black inlay	Sand jaspe with mahogany inlay	Sand jaspe with mahogany inlay
Headrests	Beige	Beige	Beige



A pair of truck wheels showing the roller bearing units

entirely different color treatment from the majority of the seats.

The paint treatment on the bulkheads is divided into two panels; the inner panel carries through to the ceiling, the outer one becomes continuous with the side wall. To achieve this, sharp contrast in light values is employed. These color schemes are shown in Table II.

Another feature of these coaches is the manner in which linoleum has been used as floor covering in simple, geometric inlay.

Sand colored Jaspe is contrasted with solid black in one of the schemes, while an alternate makes use of antique mahogany as a distinguishing note.

Other special materials include the use of satin-finish aluminum for basket racks, trim, etc.; the selection of Marlite—a colorful modern tile—for the wainscoting in the lavatories; and the use of black Micarta for all window capping.

Lighting and Electrical Equipment

Simplicity and compactness has been achieved in the design of the air-conditioning ducts and center lighting trough. A special type of illumination has been used involving a center ceiling fixture running the length of the car. Indirect light emanates from the aluminum lacquered light trough. This center trough contains 64 thirty-watt Lumiline lamps. The air ducts or louvers are trimmed with a bright red. The principal interior illumination is furnished by 38 forty-watt Safety circular ceiling lights with double prismatic lenses, the lenses having an edge-lighted skirt. There is one of these lights over each double seat. There are also two of these fixtures in the passageways and one in the men's saloon. Column lights are used in the women's room. The vestibule lights are Safety units equipped with semaphore lenses. The total lighting load in the car is 3,640 watts. The illumination intensity on the 33-in., 45-deg. reading plane with the circular ceiling lights only is 8.5 foot-candles at the center of both seats and in the aisle. The addition of the Lumiline lamps raises the intensity in the aisle to 12.5 foot-candles.

Power for the three cars is supplied by 20 kw. Safety Genemotors and on the other three by 20 kw. General Electric generators. All generators are driven by Spicer drive with automatic clutch on the Safety equipment and

(*Continued on page 20*)

Partial List of Materials and Equipment on the Delaware & Hudson Lightweight Coaches

Aluminum	Aluminum Co. of America, Pittsburgh, Pa.
Steel:	
Side and roof sheets	Armco Railroad Sales Co., Middletown, Ohio
Pressed frame members	Republic Steel Corp., Massillon, Ohio
Structural shapes in side and underframe	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Trucks	General Steel Castings Corp., Eddystone, Pa.
Wheels	Bethlehem Steel Co., Bethlehem, Pa.
Axles	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Roller bearing units	American Steel Foundries, Chicago
Roller bearings	SKF Industries, Philadelphia, Pa.
Journal bearings	Magnus Metal Corp., New York
Side bearings	Alcoma Railway Equipments, Chicago
Locknuts	Columbia Nut & Bolt Co., Bridgeport, Conn.
Journal boxes	National Malleable and Steel Castings Co., Cleveland, Ohio
Dust guards	W. N. Thornburgh Mfg. Co., Chicago
Bolster locking pin; safety locking center pin	W. H. Miner, Inc., Chicago
Springs	Union Spring & Mfg. Co., New Kensington, Pa.
Buffer springs; Fowler upper	Standard Railway Equipment Co., Chicago
Friction buffers; draft gear	W. H. Miner, Inc., Chicago
Tight Lock couplers	National Malleable and Steel Castings Co., Cleveland, Ohio
Air brakes	New York Air Brake Co., New York
Hand brake	W. H. Miner, Inc., Chicago
Clasp brake	American Steel Foundries, Chicago
Brake shoe	American Brake Shoe & Foundry Co., New York
Safety step treads	The Morton Mfg. Co., Chicago
Trap door and folding steps	The O. M. Edwards Co., Inc., Syracuse, N. Y.
Vestibule diaphragms and fixtures	Excel Curtain Co., Elkhart, Ind.
Vestibule diaphragm curtains	The Pantasote Co., Inc., New York
Window sash, dehydrated	The O. M. Edwards Co., Inc., Syracuse, N. Y.
Window sash glass	Pittsburgh Plate Glass Co., Pittsburgh, Pa.
Window glass, toilets and wash rooms	Pressed Prism Plate Glass Co., Chicago
Window sill, Micarta	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Window shades	The Pantasote Co., Inc., New York
Inside facing	L. C. Chase & Co., Inc., New York
Glazing cork strip	Armstrong Cork Products Co., Lancaster, Pa.
Doors, aluminum and steel	American Car and Foundry Co., New York
Flooring	Tuco Products Co., New York
Flooring, vestibules	Alan Wood Steel Co., Conshohocken, Pa.
Linoleum and rubber floor covering	Armstrong Cork Products Co., Lancaster, Pa.
Linoleum inlays	Sloane-Blabon Corp., New York
Chanarch floor	The Morton Mfg. Co., Chicago
Conduit fittings	Thomas & Betts Co., Elizabeth, N. J.
Copper tube and fittings	American Brass Co., Waterbury, Conn.
	Chase Brass & Copper Co., Inc., Waterbury, Conn.
	Mueller Brass Co., Port Huron, Mich.
Insulation:	
Stonefelt and Wovenstone	Johns-Manville Sales Corp., New York
Fiberglas	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Weatherstrip	Durkee-Atwood Co., Minneapolis, Minn.
Air conditioning	General Electric Co., Schenectady, N. Y.
	Safety Car Heating & Lighting Co., New York
Air-conditioning controls	Vapor Car Heating Co., Inc., Chicago
Air-conditioning grilles	Hart & Cooley Mfg. Co., Chicago
Air-conditioning grille cores	Barber-Colman Company, Rockford, Ill.
Air-conditioning filters	Owens-Illinois Glass Co., Toledo, Ohio
Registers	Tuttle & Bailey, Inc., New Britain, Conn.
Fin-tube heating unit	Vapor Car Heating, Inc., Chicago
Generator drive with safety and automatic clutches	Spicer Mfg. Corp., Toledo, Ohio
Pipe clamp	Illinois Railway Equipment Co., Chicago
Ventilators	Railway Utility Co., Chicago
Auxiliary fans	Diehl Mfg. Co., Elizabethport, N. J.
Electrical equipment	Safety Car Heating & Lighting Co., New York
	General Electric Co., Schenectady, N. Y.
Light fixtures	Safety Car Heating & Lighting Co., New York
	Bryant Electric Co., Bridgeport, Conn.
Batteries	Edison Storage Battery Div., Thomas A. Edison, Inc., W. Orange, N. J.
Charging receptacle; train-line connectors	The Pyle-National Company, Chicago
Seats	Heywood-Wakefield Co., Gardner, Mass.
Seat cushions	Dunlop Tire & Rubber Corp., Buffalo, N. Y.
	B. F Goodrich Co, Akron, Ohio
	U. S. Rubber Co., N. Y.
Seat covering	Chase, L. C. & Co., Inc., New York
	Massachusetts Mohair Co., Chicago
Tempered Presdwood	Masonite Corp., Chicago
Marlite	Marsh Wall Products, Inc., Dover, Ohio
Fabreeka	Fabrecka Products Co., Inc., Boston, Mass.
Hoppers	Dayton Mfg. Co., Dayton, Ohio
Washstands	Crane Co., Chicago
Paper towel containers; toilet paper holder	Albany Perforated Wrapping Paper Co., Albany, N. Y.
Water cooler	Henry Giessel Company, Chicago
Drinking-cup containers	U. S. Envelope Co., Springfield, Mass.
Disinfectant	U. S. Sanitary Specialties Co., Chicago
Tail gates; luggage racks	The Adams & Westlake Co., Elkhart, Ind.
Snap-on molding	Pyramid Metals Co., Chicago
Door closer	Russell & Erwin Mfg. Co., New Britain, Conn.
	Yale & Towne Mfg. Co., Phila., Pa.
Locks	Dayton Mfg. Co., Dayton, Ohio
	James L. Howard, Bridgeport, Conn.
Anti-pinch shield (end doors)	The Morton Mfg. Co., Chicago
Fire extinguisher	Pyrene Mfg. Co., Newark, N. J.
Steam-heat connectors	Barco Mfg. Co., Chicago
Paint:	
Exterior	E. I. duPont de Nemours & Co., Inc., Wilmington, Del.
Interior	Sherwin-Williams Co., Cleveland, Ohio
	Murphy Varnish Co., Newark, N. J.

Bureau of Safety Reports on

"City of San Francisco" Wreck

Derailed cars destroyed a 120-ft. Warren truss bridge and the wreckage of the train was entangled with the demolished bridge structure

THE disastrous wreck of the streamliner "City of San Francisco" on the evening of August 12, 1939, while traveling westward in Northern Nevada, was caused by "malicious tampering with the track," according to the report of the Bureau of Safety of the Interstate Commerce Commission, released December 29 following a thorough investigation on its part. According to all testimony taken at the Bureau's inquiry, including that of its own inspectors, indications are that a joint on the high rail of the curve involved had been disconnected, the angle bars removed, and the east end of the receiving rail moved inward about 4⅝ in. on the tie, setting up an ideal derailing condition—an act of deliberate sabotage.

The accident, which resulted in the death of 9 passengers and 15 dining-car employees, and the injury of 99 passengers, 1 train-service employee, one stewardess, 11 dining-car employees, and 3 train porters, occurred on the line of the Southern Pacific at a point approximately 1.55 miles east of the station at Harney, Nev., and 169.5 ft. east of bridge No. 518.54 over the Humboldt river. Approaching from the east, there is a tangent 437 ft. in. length, followed by a 3-deg. curve to the right, extending 875 ft. to the point of derailment and 1,215 ft. beyond. Bridge No. 518.54 was a through riveted Warren truss span, 120 ft. long, which had recently been strengthened and was capable of carrying Cooper's E-50 loading.

Following is the text of that part of the report pertaining to the damage to the rolling stock:

Consist of the Train

No. 101, a westbound streamline passenger train, known as the "City of San Francisco," consisted of 3 power units, an auxiliary power and dormitory unit, 2 chair units, 2 kitchen-diner units, 1 dormitory-club unit, 7 Pullman sleeping units and 1 lounge unit, in the order named, and was in charge of Conductor Edwards and Engineman Hecox. The three power units were of steel-frame construction; the bodies were of ⅜-in. plywood covered with 27-gage galvanized iron. The remainder of the units were of aluminum alloy with steel end-sills, body bolsters and cross bearers.

This train departed from Carlin (Nev.) 16 miles east of the point of accident, at 9:15 p. m., according to the train sheet, 29 min. late, and 18 min. later became derailed 169.5 ft. east of Bridge 518.54, while moving at a speed of 60 m. p. h. The three power units and the following two units, remaining coupled, became derailed, passed over the bridge on the ties, and stopped with the front end about 907 ft. west of the point of derailment. Power unit No. 1, slightly damaged, stopped upright on the ties at approximately 11 in. to the left of the line of track. Power unit No. 2, slightly damaged, and inclined at an angle of 15 deg. to the left, stopped with its front truck on the ties about 12 in. to the left of the line of track and its rear truck on the ballast. Power unit No. 3, inclined to the left at an angle of 45 deg., stopped with its front end on the fill and its rear end down the embankment, the left eave of this unit bearing indications of having struck the bridge truss; the front truck was damaged considerably. Unit No. 4 stopped on its left side down the embankment to the south of the track; its side sheets were raked and broken through by the ballast; it bore marks indicating that it had struck the south bridge-truss. Unit No. 5 stopped on its left side down the embankment to the south of the track, with the rear end 200 ft. west of the west bridge-abutment; its side sheets were sheared in numerous places and it was crushed inward along the window belt-rail; its left front corner bore marks indicating that it had struck the left bridge-truss; the tight-lock coupler at the rear was broken through the shank. Unit No. 6, a diner-kitchen car, the front section of an articulated two-unit car, became derailed and struck the bridge-truss, causing the bridge to collapse; it broke loose from the preceding unit, struck the west bridge-abutment with such force that the impact moved the abutment 1½ in. out of line, passed over the abutment, overturned to the left down the embankment west of the bridge, stopped upside down, and was practically demolished; the steel end-sill was broken loose from the aluminum alloy center-sills, which were broken about the middle of the car and were badly bent in other places; all the occupants of this unit were killed. Unit No. 7, a dining car, became derailed and was deflected to the left by the impact with the preceding car; it turned at an angle of 45 deg. and stopped about 90 ft. south of the track in the river bed; the body of the car was demolished and the frame badly distorted; the center-sills were broken just back of the bolster. Of the 24 persons killed, 21 were occupants of units Nos. 6 and 7. Unit No. 8, a dormitory-club car, became derailed, was whirled by the deflecting motion of the preceding unit, and, using the bridge frame as a fulcrum, struck the left bridge-truss with an impact sufficient to demolish the truss; the center-sills were broken at the rear bolster, at the needle beams, and at the rear-end sill; the body above the floor line was badly crushed and twisted; unit No. 9, dragging heavily as the whirling motion was being executed, caused the center-sills of unit No. 8 to be broken through at the rear end; unit No. 8 fell to the river bed and stopped upright but off its trucks; it was crushed badly at both ends. Unit No. 9, a Pullman sleeping car, articulated with unit No. 10, became derailed and dropped through the bridge opening to the river bed, stopping upright, south of and at an angle of 30 deg. to the track; its rear end was crushed inward as far as the cross-bearer or about 15 ft. from the articulated joint; the rear coupler-head was broken off, and the center-sills were broken through; the roof was crushed inward by unit No. 10 falling across it; unit No. 9 was demolished; two passengers and one porter in this car were killed. Unit No. 10, a Pullman sleeping car, became derailed, fell through the bridge opening, and stopped on the roofs of units Nos. 8 and 9, and on the overturned floor structure of the bridge;

one end was pointed upward; this car was crushed and badly distorted. These three cars, units Nos. 8, 9 and 10, were entangled with the demolished bridge structure. Unit No. 11, a Pullman sleeping car, articulated with unit No. 12, became derailed to the south at an angle of 25 deg. to the track and stopped upright in the river bed with its front end badly damaged and its rear end suspended upon the east bridge-abutment. Unit No. 12, a Pullman sleeping car, became derailed, but remained coupled to unit No. 11 and stopped upright on the embankment east of the bridge opening; one end was damaged slightly. Unit No. 13, a Pullman sleeping car, articulated with unit No. 14, became derailed but remained coupled to the units at each end and stopped upright, slightly damaged, with its front truck on the embankment and its rear truck on the ties. Unit No. 14, a Pullman sleeping car, became derailed at the front end only and remained coupled at each end. Units Nos. 15, 16, and 17 were not derailed and sustained but slight damage.

The streamline train, "City of San Francisco," was owned jointly as follows: C. & N. W., 21.63 per cent; S. P., 34.19 per cent; and U. P., 43.88 per cent.

The center of gravity of the Diesel-powered units on this train was 57 in. above the top of the rail. The overturning speed on a 3-deg. curve, with superelevation of 4 in., is 124.5 m. p. h., and a speed of 60 m. p. h. is well within the limits of safe practice as recommended by the American Railway Engineering Association.

The three power units were constructed by the Electro-Motive Corporation according to the carriers' specifications; the frames were of molybdenum steel, in rolled sections, the sides of 27-gage galvanized iron over ⅜-in. plywood, and the trucks were six-wheel type with motors mounted on the leading and trailing axles of each truck. The cars were constructed by the Pullman-Standard Car Manufacturing Co., according to the carriers' specifications; the end sills, bolsters, and needle beams were of Cor-Ten steel, of welded construction, the yield point being a minimum of 50,000 lb. per sq. in. and the ultimate strength a minimum of 70,000 lb. per sq. in. The center sills, side sills, posts, carlines, sheathing, roof, and all other framing were of aluminum alloy, the properties of which were as follows:

Material	Dimension, in.	Minimum tensile strength per sq. in., lb.	Minimum yield strength (at 2 per cent off-set) per sq. in., lb.	Minimum elongation in 2 in., per cent
Sheet and plate (17S-T) ..	0.041-0.128	55,000	32,000	18
	0.129-0.258	55,000	32,000	15
	0.259-0.500	55,000	32,000	12
Rolled shapes (17S-T)	....	50,000	30,000	16
Extruded shapes	....	50,000	35,000	12
Extruded shapes (A17S-T)	....	35,000	20,000	18
Sheet (4S½H)	0.051-0.113	30,000	24,000*	5
	0.114-0.203	30,000	24,000*	6

* Approximate.

Typical shear strengths were as follows:

	Lb. per sq. in.
17S-T	36,000
A17S-T	26,000
53S-T	24,000
4S-½H	18,000

The specifications provided for a buffing stress of 400,000 lb. at draft gear without the use of buffers. All couplers were improved tight-lock, EMC design, rubber-cushioned draft gears. The construction of this train was completed December 27, 1937, and it was placed in service January 2, 1938. The builder's records indicate that this equipment was built according to Post Office Department specifications of 400,000 lb. buffing stress, with a safety factor of two, which fixes the minimum for actual failure at 800,000 lb.

The records of the Pullman Car Company indicate that a test was conducted February 16, 1937, using a 7-ft. 10-in. section of the underframe taken from the center of a car, and containing the center-sill, side-sills, floor-stringers, one steel cross bearer, and three aluminum floor supports. This section withstood a compression load of 880,000 lb. before any permanent deformation resulted. On September 17, 1939, a test was made on a section of the center-sill cut out of the frame of the car "Twin Peaks," which was the ninth unit in the derailed train. The results of this test were as follows:

Item	No. 1	No. 2	Specification minimum
Yield point, lb. per sq. in.	35,000	34,000	39,000
Tensile strength, lb. per sq. in.	55,830	55,500	50,000
Elongation 8 in., per cent	20.7	20.3	.....
Reduction of area, per cent	28.9	26.9	.....

On October 3, 1939, the Aluminum Company of America, at its research laboratories, New Kensington, Pa., tested for tensile properties a portion of the web, the bottom flange of one channel, and the bottom angle of the center-sill of the ninth unit, the results of these tests being as follows:

Location	Tensile strength, lb.	Yield strength, set—0.2 per cent per sq. in., lb.	Elongation in 2 in., per cent	Reduction of area, per cent
Angle	56,320	37,500	25.0	38.9
Channel web	56,030	34,700	24.0	34.3
Channel toe	56,770	37,100	24.5	35.7
Channel heel	56,750	39,100	24.0	40.8
Average	56,470	37,100	24.4	37.4
Specified minimum	50,000	30,000	16.0	...

The following is a statement of damage as formulated by the carriers and the Pullman Company:

Position in train, Unit No.	Name	Damage
1	Power unit (S.F. 1)	$11,000.00
2	Power unit (S.F. 2)	11,500.00
3	Power unit (S.F. 3)	14,000.00
4	Baggage-dormitory (S.F. 101)	43,500.00
5	Market Street (S.F. 401)	45,000.00
6	Presidio (S.F. 601)	117,073.29*
7	Mission Dolores (S.F. 602)	103,199.37*
8	Embarcadero (S.F. 701)	118,337.90*
9	Twin Peaks (N-120)	90,658.36*
10	Chinatown (N-121)	86,446.28*
11	Fisherman's Wharf (N-122)	18,500.00
12	Golden Gate Park (N-123)	8,500.00
17	Nob Hill (S.F.)	2,600.00
	Total	670,315.20

* Demolished.

Observations of the Commission's Inspectors

The trucks of the power units were examined, and it was observed that the motor housings and the pedestal binder bolts showed considerable wear, indicating abrasive action obviously sustained by sliding on the top of the rails. Grooves on the left side of the motor housings of power units Nos. 1, 2, and 3 indicated contact with the top of the rails; on all motor housings the grooves were worn to a depth which varied between 3/32 in. and 7/16 in. These marks were blue in color, which indicated friction burning. Holes in the motor housings indicated probable contact with the bridge guardrail. The inner faces of the right-pedestal binder-bolt nuts, which were 1-in. hexagonal nuts, were severely abraded and burned because of contact with the outside of the ball of the north rail, except one nut at the right No. 2 wheel of truck No. 1 of power unit No. 1, which was worn to less than half its thickness; it was fused to its bolt, evidently due to sliding on top of the rail head. There was somewhat greater wear on the motor housings and the pedestal binder-bolts on unit No. 1 than on the two following units.

The inspectors observed that the cars withstood impact shock up to a certain degree, after which some of

(*Continued on page 19*)

Designing for

High Tensile Steels*

By H. M. Priest†

Charts and formulas for the solution of problems involving a combination of stresses and working formulas based on the specification for post office cars are presented

Combined Stresses

MANY structural members are subjected to a combination of loads that produce a combination of stresses. One of the most frequent combinations is that of direct compression and bending. Several charts, to be presented, will be found useful in the solution of such problems. Fig. 18 is illustrative of a few ways in which compression and bending are combined.

Fig. 18 (a) represents a column or compression member in which the applied load, P, has an eccentricity, e, with respect to the neutral axis of the section. The moment, Pe, produces a deflection of the column in the direction of the dotted line. The additional deflection adds to the arm of the load P at the center, thereby increasing the moment and adding another increment to the deflection. The dotted line indicates the elastic line of the column when it finally reaches equilibrium with a deflection Δ. The moment then equals $P \times (e + \Delta)$.

From integral calculus an expression for this moment can be obtained and is represented by the following equation.

$$\text{Maximum moment} = M \sec \frac{\pi}{2}\sqrt{\frac{P}{P_{cr}}} \quad \ldots\ldots (56)$$

in which

M = Moment Pe, in-lb.
P = Load on column, lb.
$P_{cr} = \dfrac{\pi^2 EI}{L^2}$, lb.
I = Moment of inertia of column, in.^{4}
L = Unsupported length of column in.
E = Modulus of elasticity, lb. per sq. in.

The combined stresses in the column will be given by the following formula, in which the first term is the average compression and the second term represents the fibre stress in bending. The negative sign represents compression and the positive sign is for tension.

$$\text{Total stress} = -\frac{P}{A} \pm \frac{\text{Max. Mom.}}{S} \quad (57)$$

in which

A = Area of column section
S = Section modulus of column section

The examination of an eccentrically-loaded column will be facilitated by the chart of Fig. 19 which is based on the formula

$$S_{max}\left(\frac{L}{r}\right)^2 = \frac{PL^2}{Ar^2}\left[1 + \frac{e}{s}\sec\sqrt{\frac{1}{4}\frac{PL^2}{EAr^2}}\right] \quad (58)$$

in which

S_{max} = Total maximum stress in compression, lb. per sq. in.
e = Eccentricity of load P, in.

s = Ratio of $\dfrac{\text{section modulus}}{\text{area}}$

The ratio c/s in Formula 58 is the same as $a = cc/r^2$ in the column secant formula discussed in Part I.

The application of the chart to a specific example will best illustrate its use. Take the column shown in Fig. 18 (d) with an unsupported length of 462 in. Let the problem be the determination of the maximum load P, acting with an eccentricity of 3.60 in. In the discussion of compression members in Part I, it was stated that the ultimate stress in a column is the yield-point stress of the steel. For this example, assume the yield point equals 33,000 lb. per sq. in. and S_{max} is then made equal to 33,000.

Several items have to be computed before entering the chart.

$$s = \frac{35.0}{9.71} = 3.60 \qquad \frac{L}{r} = \frac{462}{4.20} = 110$$

$$\frac{e}{s} = \frac{3.60}{3.60} = 1.0 \qquad \left(\frac{L}{r}\right)^2 = 12{,}100$$

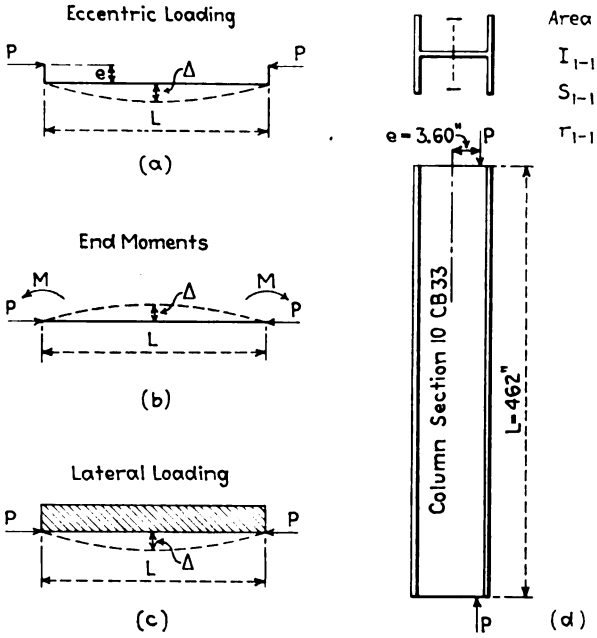


Fig. 18—Combined stresses in compression members

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* Parts I and II of a previous paper by the same author, entitled Designing for High Tensile Steels, were published in the May and June, 1936, issues, respectively, of the *Railway Mechanical Engineer*. This paper was published in two parts, designated as Parts III and IV, Part III appearing in the December, 1939, issue and Part IV appearing in this issue.

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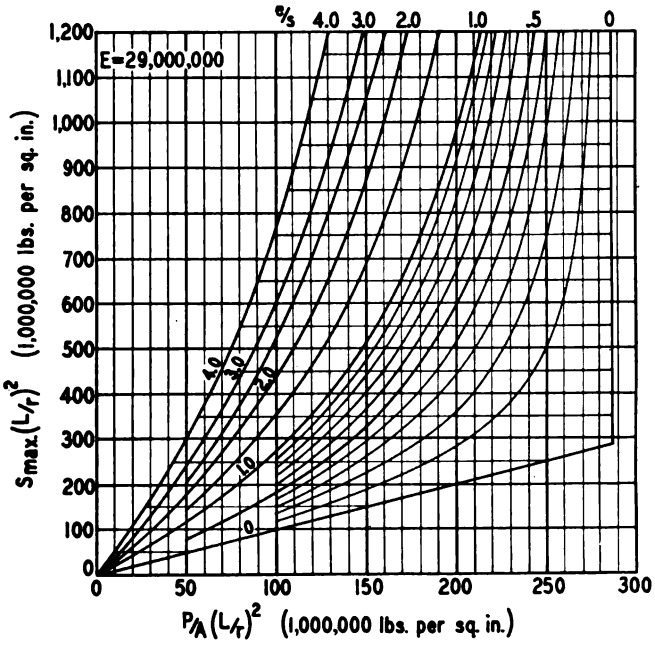


Fig. 19—Chart for designing eccentrically loaded compression members

$$S_{max}\left(\frac{L}{r}\right)^2 = 33{,}000 \times 12{,}100 = 400{,}000{,}000$$

Enter the chart at this value of $S_{max}\ (L/r)^2$ and follow horizontally across to the sloping line for $e/s = 1.0$ and read the value of 130,000,000 for $P/A\ (L/r)^2$. Knowing the value of $(L/r)^2$ we obtain

$$\frac{P}{A} = \frac{130{,}000{,}000}{12{,}100} = 10{,}740 \text{ lb. per sq. in.}$$

$$A = 9.71 \text{ sq. in.}$$

therefore

$$P = 10{,}740 \times 9.71 = 104{,}300 \text{ lb.}$$

It should be remembered that this value of P is the ultimate load which the column can sustain without the combined unit stress exceeding the yield-point stress. The factor of safety must be applied to obtain the working load. With a factor of safety of 1.8, the working load becomes 57,940 lb.

In many cases the load on the column will be known and the designer will be interested in calculating the maximum stress. The chart in Fig. 20 will facilitate this solution. It is the graphical solution of the term

$$\left[\sec \frac{\pi}{2}\sqrt{\frac{P}{P_{cr}}}\right]$$

in Formula 56, designated by the letter N.

Let us use the same column as in Fig. 18 (d) and assume that the ultimate load $P = 104{,}300$ lb., as just found in the previous problem.

$$P_{cr} = \frac{\pi^2 \times 29{,}000{,}000 \times 170.9}{462 \times 462} = 229{,}200 \text{ lb.}$$

$$\frac{P}{P_{cr}} = \frac{104{,}300}{229{,}200} = .455$$

Enter the chart at this value of P/P_{cr} and follow vertically to the curve and read $N = 2.06$.

Then

Maximum moment $= 2.06 \times (104{,}300 \times 3.60) = 773{,}500$ in.-lb.

$$\frac{P}{A} = \frac{104{,}300}{9.71} = -10{,}740 \text{ lb. per sq. in.}$$

$$\frac{M}{S} = \frac{773{,}500}{35.0} = -22{,}100 \text{ lb. per sq. in.}$$

Total stress $= -32{,}840$ lb. per sq. in.

This is in practical agreement with the value of $S_{max} = 33{,}000$ lb. per sq. in. which was assumed in the determination of the ultimate load P.

The reader will recognize in the formula for P_{cr} the well known Euler formula and some doubt may arise as to the validity of the formula for high values of P_{cr}. In this discussion of combined stresses P_{cr} is more in the nature of a mathematical constant and whatever its calculated value, that value is to be used in computing the ratio, P/P_{cr}.

Fig. 18 (b) is another illustration of combined compression and bending. The end moments M correspond precisely with the moments Pe and the solution of any problem is handled in the same manner just discussed. The chart in Fig. 20 may be used to advantage. It will also be found helpful in dealing with compression members having some end fixity or continuity over supports.

Another common example is shown in Fig. 18 (c) in which the compression member supports a laterally applied load. The equation of the elastic line of such a member can become a very complicated one and it is not practical to attempt to cover a wide variety of cases. Two cases have been selected for discussion, first, because they are encountered in car construction and second, for the reason that they are common to many structural designs.

The first case deals with a uniformly distributed lateral load as shown in Fig. 21. In order to broaden the scope of the chart, provision has been made for distributing the load over a portion of the span or length of the column.

As was the case with Fig. 20, this chart gives a graphical solution of the constant N in the equation for the maximum moment.

$$\text{Maximum moment} = N\ w\ L^2 \qquad (59)$$

When the full span is laterally loaded, it is evident that maximum moment and deflection will occur at the

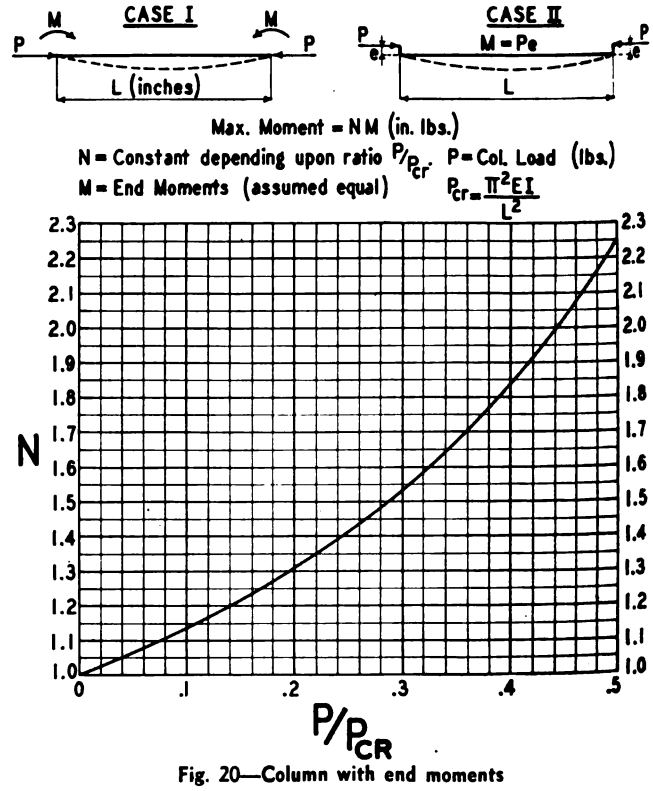


Fig. 20—Column with end moments

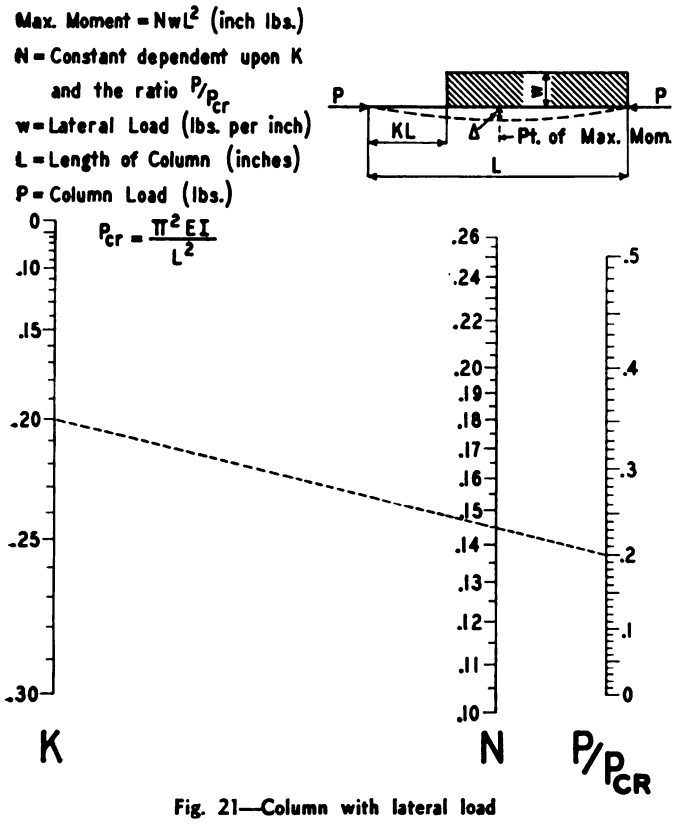


Fig. 21—Column with lateral load

center of the span. This is not true for partial loading, nor do the two points coincide. We are more interested in the point of maximum moment, which may move away from the center about .04 of the span length when $K = .3L$.

The moments produced by eccentricity and lateral load may be combined by addition, due care being exercised to observe the sign of each moment or the kind of stress they produce in a given portion of the member. The application of the charts in Figs. 20 and 21 will be illustrated by an example taken from the design of a compression chord in a pin-connected bridge.

Fig. 22 (a) shows the cross section of the chord member and gives the properties required for design purposes. The length between pins is 30 ft. Let the problem be the determination of the stresses in the chord for a direct compression load of 715,000 lb. and a lateral load of 200 lb. per ft., representing the dead weight of the chord with its details included. Assume that the line of action of the compression is on the center line of the web plates, thus having an eccentricity, $e = 1.112$ in., with respect to the neutral axis of the section. The loading is shown in Fig. 22 (b). The values for P_{cr} and the ratio of P/P_{cr} are also given.

Fig. 22 (c) treats the uniform lateral load, $w = 200/12 = 16.67$ lb. per in. acting with the direct load, $P = 715{,}000$ lb. The dotted line indicates the final position of the member and it is evident that the bending moment will produce compression in the top flange and tension in the bottom flange. The calculation of this moment depends upon the constant N in the equation $M = N\,w\,L^2$. Enter the chart in Fig. 21, lay a straight edge across the nomograph from $K = 0$ to $P/P_{cr} = .077$, and read $N = .136$. The maximum moment and the bending stresses in the flanges are as follows:

$$\text{Maximum moment} = .136 \times 16.67 \times 360 \times 360 = 293{,}800 \text{ in.-lb.}$$

$$\text{Stress in top flange} = \frac{293{,}800}{419.3} = -701 \text{ lb. per sq. in.}$$

$$\text{Stress in bottom flanges} = \frac{293{,}800}{336.2} = +874 \text{ lb. per sq. in.}$$

The case of the eccentricity is shown in Fig. 22 (d). Since the load acts below the neutral axis, the member will be bent upward to the position of the dotted line, producing tension in the top flange and compression in the bottom flanges. From Fig. 20, the value of N is 1.10 for $P/P_{cr} = .077$. The maximum moment and the stresses in this case are

$$\text{Maximum moment} = 1.10 \times (715{,}000 \times 1.112) = 874{,}600 \text{ in.-lb.}$$

$$\text{Stress in top flange} = \frac{874{,}600}{419.3} = +2{,}086 \text{ lb. per sq. in.}$$

$$\text{Stress in bottom flanges} = \frac{874{,}600}{336.2} = -2{,}601 \text{ lb. per sq. in.}$$

$$\text{The direct stress } \frac{P}{A} = \frac{715{,}000}{52.94} = -13{,}506 \text{ lb. per sq. in.}$$

Summarizing the stresses

	Stress in top flange, lb. per sq. in.	Stress in bottom flange, lb. per sq. in.
Direct	−13,506	−13,506
Uniform load	− 701	+ 874
Eccentricity	+ 2,086	− 2,601
Total stress	−12,121	−15,233

in which the minus sign denotes compression and the plus sign denotes tension.

The second type of lateral load is the triangular, or uniformly varying, distribution as shown in Fig. 23. The scope of the diagram has been extended by the provision for the loading to extend over a portion of the span as was done for the uniform load. The operation of the nomographic chart is identical with that already explained for Fig. 21.

The maximum moment occurs at a point about .58 L from the left-hand end when $K = 0$ and at .61 L for $K = 0.3$. It will be evident that adding the moment, obtained from the chart in Fig. 23, to moments due to eccentricity or uniform lateral load will be on the safe side since the latter moments may be reduced not over 5 per cent at a point .61 L from the left-hand support.

An illustrative problem, setting forth the use of several of the charts and formulas, is given in Fig. 24. Let

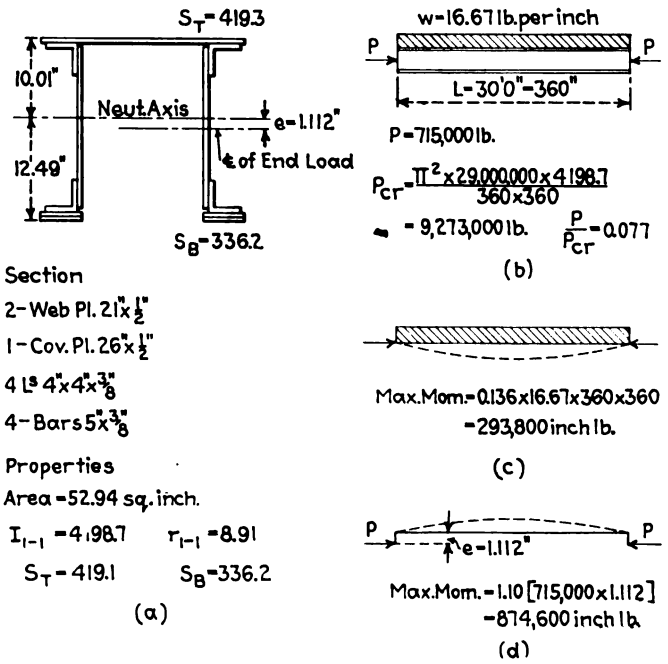


Fig. 22—Combined stresses in bridge chord

it be the problem to determine whether the laterally loaded strut has a factor of safety of 1.8 when made of a steel having a yield point of 50,000 lb. per sq. in.

The cross-section of the strut was selected with a dimension of 6¼ in. between the rivets or spot welds connecting the top cover to the flanges of the channel section. This dimension provides an illustration of the effective width of cover to be included with the channel section.

Referring to Fig. 15

$$2W_2 = 1.70 \times .125 \sqrt{\frac{29,000,000}{50,000}} = 5.12 \ (5\tfrac{1}{8} \text{ in.})$$

therefore, a portion of the cover plate at the center 1⅛ in. long (6¼ — 5⅛) is considered as ineffective and was neglected in calculating the properties of the strut section given in Fig. 24.

The first step is to multiply the end and lateral loads by the factor of safety of 1.8, as indicated on the sketch. Then the value of the critical end load, P_{cr}, should be computed and the ratio of the actual end load to the critical end load should be determined. The calculations of these two quantities is shown on the sketch.

Direct load—The direct unit compressive stress equals the end load divided by the area:

$$\frac{P}{A} = \frac{27,000}{3.40} = -7,940 \text{ lb. per sq. in.}$$

End eccentricity—From the chart in Fig. 20:

$$\frac{P}{P_{cr}} = .279 \qquad N = 1.48$$

$$M = 1.48 \times 27,000 \times 1.372 = 54,830 \text{ in.-lb.}$$

$$\text{Top flange } f = \frac{54,830}{4.69} = -11,690 \text{ lb. per sq. in.}$$

$$\text{Bottom flange } f = \frac{54,830}{3.30} = +16,620 \text{ lb. per sq. in.}$$

Uniform lateral load—From the chart in Fig. 21:

$$\frac{P}{P_{cr}} = .279 \qquad K = 0$$

$$N = .175 \qquad M = .175 \times 16.2 \times (144)^2 = 58,790 \text{ in.-lb.}$$

$$\text{Top flange } f = \frac{58,790}{4.69} = -12,530 \text{ lb. per sq. in.}$$

$$\text{Bottom flange } f = \frac{58,790}{3.30} = +17,810 \text{ lb. per sq. in.}$$

Uniformly varying lateral load—From the chart in Fig. 23:

$$\frac{P}{P_{cr}} = .279 \qquad K = .25$$

$$N = .0478 \qquad M = .0478 \times .54 \times (144)^3 = 77,070 \text{ in.-lb.}$$

$$\text{Top flange } f = \frac{77,070}{4.69} = -16,430 \text{ lb. per sq. in.}$$

$$\text{Bottom flange } f = \frac{77,070}{3.30} = +23,360 \text{ lb. per sq. in.}$$

Summary of stresses—

	Stress in top flange, lb. per sq. in.	Stress in bottom flange, lb. per sq. in.
Direct load	— 7,940	— 7,940
End eccentricity	—11,690	+16,620
Uniform lateral load	—12,530	+17,810
Varying lateral load	—16,430	+23,360
Total combined stress	—48,590	+49,850

in which the minus sign denotes compression and the plus sign denotes tension. The combined stress in either flange does not exceed the yield-point of 50,000 lb. per sq. in., hence the strut has a factor of safety of at least 1.8 with the assumed loading conditions.

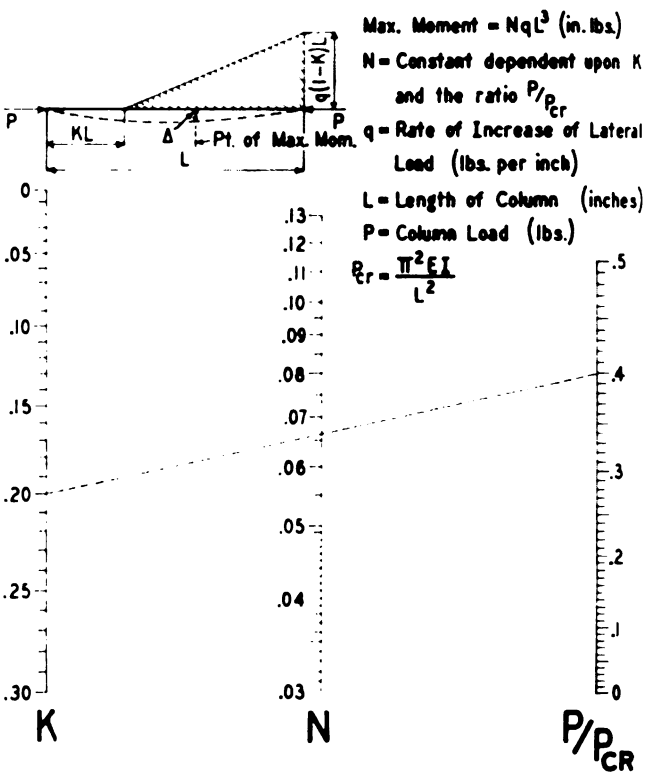


Fig. 23—Column with lateral load

Conclusion

The subject of elastic instability, or buckling strength, is one that is under active experimental and theoretical investigation. An engineer must still use judgment in the application of the formulas so far proposed for the solution of designing problems. It is believed that the data in this paper will provide a working basis for meeting many present day problems in a safe and satisfactory manner and enable engineers to proceed with assurance in a field where much remains to be studied.

Appendix—Post Office Department Specification

The specification for the construction of full and apartment railway post office cars, revised to July 20, 1938, contains provisions covering the buckling stability of any flat surface under compression in its plane. It seems

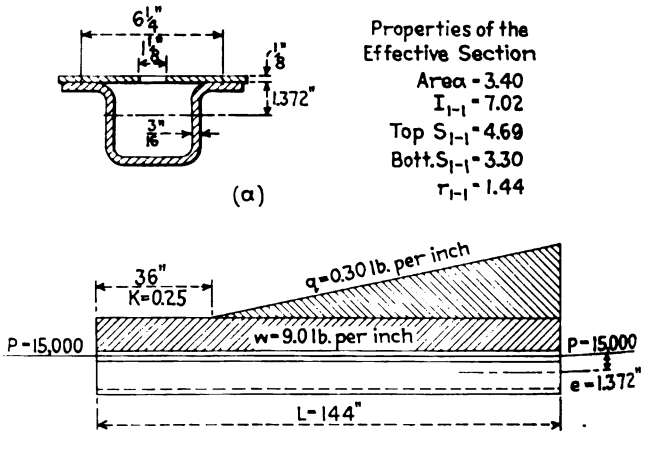


Fig. 24—Laterally loaded strut

appropriate, therefore, to add an appendix to this paper in which a set of working formulas, based upon the specification, can be presented as in Fig. 25.

The following excerpts are taken from Section 24 (Stresses) of the specification:

"Axial compression stresses in members, or elements of members, must not exceed those allowed by the following column and stability formulas:

For $\frac{L}{r} < \sqrt{\pi \frac{2E'}{F}}$

Then $\frac{P}{A} = F - \frac{F^2}{4\pi^2 E'}\left(\frac{L}{r}\right)^2$, lb. per sq. in.

For $\frac{L}{r} > \pi\sqrt{\frac{2E'}{F}}$

Then $\frac{P}{A} = \frac{\pi^2 E'}{\left(\frac{L}{r}\right)^2}$, lb. per sq. in.

"These formulas give a nominal safety factor of 2.0 for reasonably restrained end condition.

in which L = Length of column, center to center of connections, in.
r = Least radius of gyration of column cross-section, in.
E' = Secant modulus of elasticity as derived from the tensile stress-strain diagram
F = Maximum allowable unit stress
P = Axial load, concentric, lb.
A = Area of column cross-section, sq. in.

"Stresses described above as maximum allowable are contingent upon the ability of webs and flanges to resist these stresses without buckling. For compression in the plane of any flat surface, this ability to resist buckling shall be determined by substituting the following equivalent slenderness ratios in the foregoing column formulas:

For outstanding flanges $\frac{L}{r} = 5.0\,\frac{b}{t}$

For other than outstanding flanges $\frac{L}{r} = 1.8\,\frac{b}{t}$

AXIAL COMPRESSION			
Yield Point	$\frac{P}{A} = F - \frac{F^2}{4\pi^2 E'}(L/r)^2$	Validity Limit (L/r)	$\frac{P}{A} = \frac{\pi^2 E'}{(L/r)^2}$
32,000	$16{,}000 - .224\,(L/r)^2$	189.2	$\frac{286{,}220{,}000}{(L/r)^2}$
50,000	$25{,}000 - .546\,(L/r)^2$	151.3	$\frac{286{,}220{,}000}{(L/r)^2}$
COMPRESSION ON OUTSTANDING FLANGES			
Yield Point	$\frac{P}{A} = F - \frac{F^2}{4\pi^2 E'}(5.0\,b/t)^2$	Validity Limit (b/t)	$\frac{P}{A} = \frac{\pi^2 E'}{(5.0\,b/t)^2}$
32,000	$16{,}000 - 5.59\,(b/t)^2$	37.8	$\frac{11{,}449{,}000}{(b/t)^2}$
50,000	$25{,}000 - 13.65\,(b/t)^2$	30.3	$\frac{11{,}449{,}000}{(b/t)^2}$
COMPRESSION ON OTHER THAN OUTSTANDING FLANGES			
Yield Point	$\frac{P}{A} = F - \frac{F^2}{4\pi^2 E'}(1.8\,b/t)^2$	Validity Limit (b/t)	$\frac{P}{A} = \frac{\pi^2 E'}{(1.8\,b/t)^2}$
32,000	$16{,}000 - .724\,(b/t)^2$	105.1	$\frac{88{,}340{,}000}{(b/t)^2}$
50,000	$25{,}000 - 1.769\,(b/t)^2$	84.1	$\frac{88{,}340{,}000}{(b/t)^2}$
$E' = 29{,}000{,}000$			

Fig. 25—Formulas for axial compression and buckling stability for steels having yield points of 32,000 and 50,000 lb. per sq. in.

in which b = Flat width at right angles to direction of stress, in.
t = Thickness, in."

The specification permits a direct unit stress in compression for side sills and framing members of $F = 16{,}000$ lb. per sq. in. for rolled mild open-hearth steel. For comparison purposes, the yield point of this steel is taken as 32,000 lb. per sq. in. A steel having a yield point of 50,000 lb. per sq. in. is permitted to have a working unit stress of $F = 16{,}000 \times 50{,}000/32{,}000 = 25{,}000$ lb. per sq. in.

Fig. 25 is a tabulation of the formulas for axial compression and buckling stability for steels having yield points of 32,000 and 50,000 lb. per sq. in. For lack of space, charts based upon these formulas have not been included, but can be readily prepared by designers who desire to construct their own diagrams.

Bureau of Safety Reports on "City of San Francisco" Wreck

(*Continued from page 14*)

them collapsed. An absence of intermediate stages of damage was noticeable; in cases of badly damaged material the state of damage was total collapse. One underframe indicated compression failure. There was but little damage in cases where the tight-lock couplers and articulated joints held. The only instance of telescoping was at the ninth unit; it became separated at its articulated joint and the shank of the tight-lock coupler at the opposite end failed. The greatest damage sustained by the cars collectively consisted of failure of the superstructures. The aluminum alloy metal in many cases tore loose from the rivets and was cut through in places where it had been dragged on the ballast; very few steel rivets were sheared off. There was no indication of dispersion of strain; in many instances a badly torn section was adjacent to a section which had not buckled in the slightest degree. In many instances the tie straps between center-sill flanges were buckled.

Discussion

When the power units became derailed on the curve, the first power unit traveled to the left a few inches, because of following a tangential line; however, the motor housings and the pedestal binder-bolts prevented the power unit from leaving the roadbed.

The cars involved in this accident were constructed, for the most part, of aluminum alloy. As shown by the records, these cars were designed and constructed in accordance with the requirements of the Post Office Department specifications for railway mail cars; the underframes were designed to withstand a buffing stress of 400,000 pounds. The Postal Department specifications require a safety factor of two in the calculation of buffing stresses, fixing the minimum for actual failure because of buffing stock at 800,000 lb. To determine that the requirements of these specifications were complied with, the manufacturer apparently relied upon calculations and results of tests of a section of underframe similar to that of the cars in the "City of San Francisco." This section was 7 ft. 10 in. in length and withstood a compression test of 880,000 lb. before permanent deformation occurred. After the accident, on September 17, 1939, similar tests were made at the Pullman Car Manufacturing Co. laboratory; a section of frame removed from the car "Twin Peaks" was used and the

results indicated that the material was in accordance with the specifications.

On October 3, 1939, The Aluminum Co. of America, at its laboratory, conducted tests on a portion of the center-sill removed from the car "Twin Peaks," the ninth unit, using a piece near the point where a fracture had occurred. The results of this test demonstrated that the material was well above the minimum requirements.

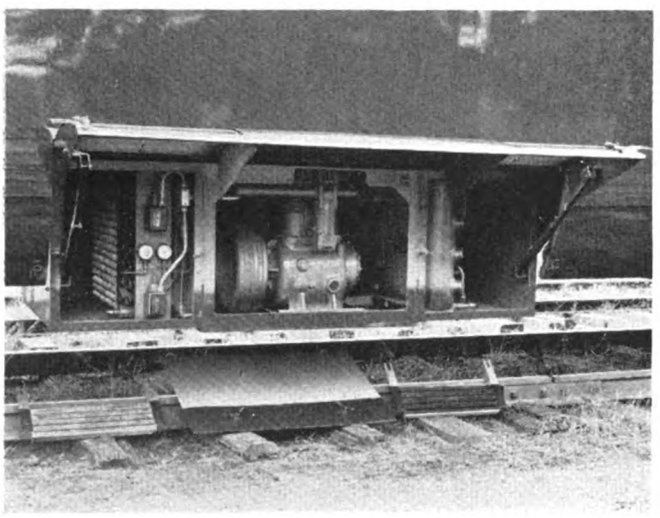
These cars withstood impact shock up to a certain degree, beyond which there was practically a total collapse; there appeared to be no intermediate stage of damage. A great amount of damage to the superstructures was sustained by the cars involved in this accident, especially those where the most fatalities occurred. The aluminum alloy sheathing, which forms a part of the girder construction of the car sides, manifested a tearing characteristic, in that the metal readily tore loose from the rivets; also it was cut and torn badly because of being dragged on the ballast. There was but little indication of dispersion of strain; in many instances a badly torn section was adjacent to one that did not buckle in the slightest degree.

Any attempt to draw conclusions as to what might have occurred had standard all-steel passenger cars been involved in this accident, would be purely conjectural and speculative.

D. & H. Lightweight Coaches

(*Continued from page 12*)

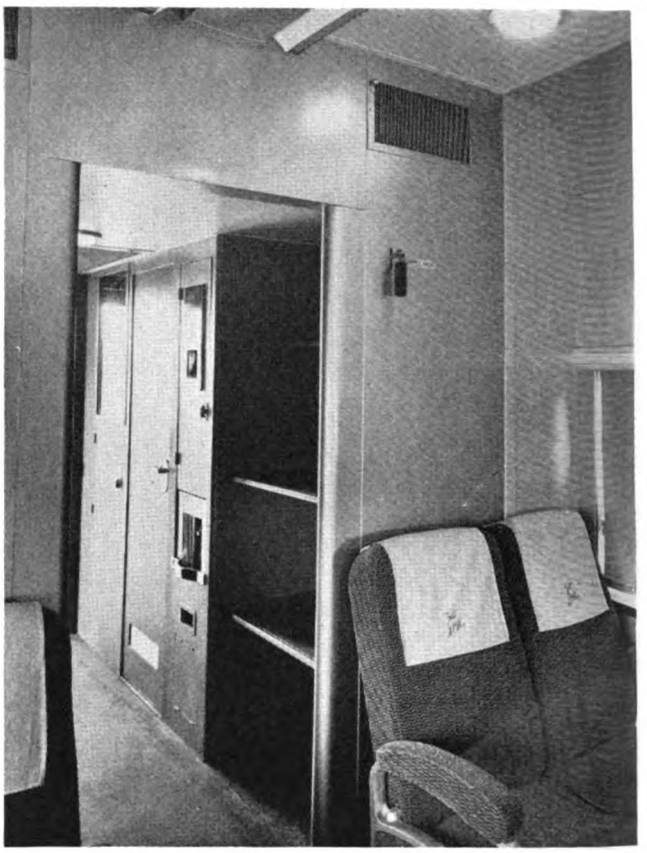
the Safety clutch on the G. E. equipment. The storage battery equipment consists of 50 cells of Edison batteries having a capacity of 510 amp. hr. at 64 volts. A novel feature of the battery compartment is the balanced door, which swings underneath when open, and no part of which comes closer than approximately 6½ in. to the



Air Conditioning compressor compartment

third rail in electrified yards. When the door is closed, its two ends form a baffle with the ends of the compartment to provide ventilation.

The air-conditioning equipment is electro-mechanical, of 7 tons capacity. Three cars have General Electric equipment and the other three have the Safety system. Interior temperatures are regulated by the Vapor cor-relative control. Supplementing the air-conditioning system are four fans behind bulkhead grilles exhausting to the atmosphere. These fans are for emergency use.



Luggage compartment adjacent to the men's room

Special attention was given the design of the toilet facilities to assure a departure from the conventional arrangement. All of the pipes and fittings have been concealed and the space under the wash stands has been enclosed thereby providing a receptacle for soiled towels.

Other Features of Equipment

The cars are well insulated to insure a comfortable temperature in all seasons, there being 2 in. of insulation in the roof, ends and sides, and 1-1½ in. in the floor.

Double glazed O. M. Edwards sash is used, the inner sash being hinged to facilitate economical window cleaning. Activated alumena is used between the sash to absorb any condensation or moisture which might collect. Further safety to the passengers is insured by the fact that ¼ in. safety glass is used in the inner sash.

Large parcel racks are provided, running the full length of the car. Supplementing these racks and located at the saloon end of the car is a spacious luggage locker for the heavier baggage. The ends doors are equipped with the Dayton push-pull type of door locks.

The four-wheel trucks under these cars have cast steel frames. The wheels are 36 in. diameter and are equipped with A. S. F. roller bearing units with SKF bearings. The wheels are carefully balanced and the treads are ground after mounting on the axles. The wheel pairs are then finally balanced to insure riding comfort. The trucks are equipped with Simplex unit cylinder clasp brakes and are insulated.

The cars are equipped with National tight lock couplers, New York Type HSC, Schedule D-22-A brake equipment and Miner friction draft gears and buffers.

EDITORIALS

"City of San Francisco" Wreck Report

The report of the Bureau of Safety on the wreck of the streamliner City of San Francisco, which occurred on the evening of August 12, noted in this issue, has been awaited with unusual interest because the principal materials of construction of the cars were strong alloys of aluminum, one of the several types of new structural materials which have made possible marked savings in the weights of passenger-train cars. The essential facts as far as the performance of the rolling stock in the wreck is concerned are that the train, moving westward, was derailed toward the outside of a long three-degree curve, 169.5 ft. east of a 120-ft. Warren truss bridge over the Humboldt river. As was inevitable, a portion of the train, which was moving at 60 m. p. h. at the time of the accident, came into violent contact with the bridge trusses, completely destroying the bridge and precipitating a number of the cars onto the river bed some 33 ft. below the track elevation, several of them entangling with the twisted members of the bridge trusses.

There is ample evidence in published photographs, taken at the scene before the wreckage had been disturbed, that there had been extremely violent contacts between some of the cars in the train and parts of the bridge structure. These violent blows began with the kitchen-diner unit of the two-unit articulated kitchen-dining car, the sixth unit in the train counting the three locomotive units. The front end of this unit is said to have collided with the west abutment with sufficient violence to displace the abutment 1½ in. against the backfill, a collision impact which, in view of the probable increasing misalignment of the derailed vehicles the farther they were from the front end of the train, would account for the evidence of violent change of direction of the four units immediately following, and the entanglement of some of them with the falling bridge structure. It would seem highly probable that the puncturing and flailing action of falling bridge members contributed materially to the destruction wrought on these cars. The only cars the structures of which were not intact after the wreck were the kitchen-diner unit and the three units following, and these are the cars which were involved in the wreck of the bridge. The fourth following unit, which fell on its side on top of the pile, shows no evidence of failure of the structure, except possible punctures of the side on which it lay.

The inspectors of the Bureau of Safety observed that "the cars withstood impact shock up to a certain degree, after which some of them collapsed. An absence of intermediate stages of damage was noticeable; in cases of badly damaged material the state of damage was total collapse. One underframe indicated compression failure." The discussion of the evidence at the conclusion of the report contains the statement that "A great amount of damage to the superstructures was sustained by the cars involved in this accident, especially those where the most fatalities occurred. The aluminum-alloy sheathing which forms a part of the girder construction of the car sides, manifested a tearing characteristic in that the metal readily tore loose from the rivets; also, it was cut and torn badly because of being dragged on the ballast. There was but little indication of dispersion of strain; in many instances a badly torn section was adjacent to one which had not buckled in the slightest degree."

The major portion of the report on this wreck is devoted to establishing beyond peradventure of a doubt that the derailment of the train was caused by the deliberate misalignment of a rail on the outside of the curve. Nine and three-quarter pages of the report are devoted to the presentation of this evidence. Considering the importance of establishing this fact, such care is highly commendable. In view of the fact that this is the first serious wreck of a train made up of vehicles of aluminum-alloy construction and that it has attracted widespread public attention partly for that reason, it would seem that equally meticulous efforts would have been justified in presenting all the facts and evidence bearing upon the probable forces to which the damaged cars were subjected to correlate with the observations in the report bearing on the behavior of the material of which they were built. For instance, is it not important to know the direction from and the time interval within which the forces were applied in order to evaluate the apparent absence of "dispersion of strain" and the extensive damage to the superstructures of the cars involved with the bridge? Again, what is the significance of the statement that "the aluminum-alloy sheathing which forms a part of the girder construction of the car sides manifested a tearing characteristic in that the metal readily tore loose from the rivets" unless the evidence includes the facts concerning the crushing and shearing strength of the rivets as well as the crushing and shearing strength of the material of the sheets?

Such facts concerning the performance of the equipment as are contained in the report and in published photographs of the wreck suggest that these cars were subjected to forces beyond those for the resistance of which it is practicable to design passenger cars and that some of these forces at least were applied in directions not anticipated in the design of any passenger cars. Therefore, failures were inevitable. In view of the absence from the reports of facts on which the inspectors based their observations, it seems unfortunate that

the comment in the report on this aspect of the wreck was not confined to the closing statement that "any attempt to draw conclusions as to what might have occurred had standard all-steel passenger cars been involved in this accident would be purely conjectural and speculative."

Steam and Diesel Locomotive Comparisons

In statements comparing the performance and costs of operation of Diesel-electric locomotives with steam locomotives the steam locomotive as a type is almost always placed at an unfair disadvantage because the comparison is made between the proposed new Diesel locomotive and whatever steam locomotives happen to be performing the service at the time. The question "what would be the results if the most modern steam locomotives were to be considered for this service" seems seldom to be asked.

There are at least three aspects of such comparisons which cannot safely be passed over without careful consideration of both types of motive power on a basis of equality as far as the modern character of the design is concerned. First is the question of fuel cost. It may make a considerable difference in the results whether the cost of coal required to perform a given service is based on a thermal efficiency of three or four per cent or whether it is based on six or seven per cent. Then there is the question of the horsepower-weight ratio. Steam passenger locomotives are in service today with a gross weight of engine and tender of as low as 130 lb. per hp. and there are a number of them in service with weights around 150 lb. per hp. Advantage in this respect, therefore, lies with the Diesel-electric locomotive only where the comparison is made with the older or less well proportioned steam locomotives.

Another element of locomotive operating cost is the cost of maintenance. Here it is equally important that the performance of modern steam motive power be used in such comparisons. Older locomotives which during their life have been required to perform services faster and heavier than those for which they were originally built are far from showing the best economy in maintenance cost of which steam motive power is capable.

It is not the intention to imply that Diesel-electric motive power has not given an excellent account of itself. This fact is well established in switching service and is also being established in long distance passenger runs. In the latter case, however, the considerations leading to the decisions in favor of Diesel-electric locomotives have included factors not strictly of an economic character. There has been the element of glamour which, in some cases at least, has been weighted heavily in favor of the Diesel. In considering this factor, itself, however, the comparison has generally been with existing steam locomotives. New steam locomotives in the design of which style factors have been considered have also been notably effective in this respect.

It is important, therefore, from whatever aspect the comparison is viewed that the steam locomotive, modern in proportions as well as in style, represent the type in the competition with the Diesel-electric locomotives. Only in this way can there be any assurance that the best solution for each situation will be effected.

Should Old Cars Be Modernized?

The marked decrease in programs for the installation of air conditioning equipment in existing passenger cars during the past year would indicate, at first thought, that the roads are reaching a point where the major portion of such railroad-owned main-line equipment has been modernized in that respect. There is, however, another important factor which may have, or at least should have, an influence on further expenditures along that line. That factor is the question as to the economic advantages of expenditures for the modernization of old cars.

Disregarding entirely the influence of lower passenger fares on increases in passenger travel, the experience of the roads during the past three or four years has definitely proved that business has been attracted to the railroads by the expenditures that have been made for air conditioning. The trend to modern lightweight cars has provided an impetus to the recapture of a substantial amount of passenger travel. In all fairness it should be said that the most popular trains have been those that have been operated on greatly accelerated schedules and on roads operating such lightweight high-speed trains the experience has been that the traveling public prefers those trains to trains operating with standard equipment, even though the standard equipment may be air conditioned or otherwise modernized. On roads where no new lightweight high-speed trains are being operated in competition with standard equipment, the public has shown a definite preference for the modernized cars and there are indications that business might be increased with new equipment.

From an operating standpoint there are definite advantages in the lighter equipment. Without becoming involved in detailed cost figures, it probably will be conceded that lighter trains present certain advantages and possible economies. From the standpoint of the patron they are much more attractive and more comfortable to ride on.

From an operating standpoint there are economies such as the ability to haul more cars per train with a given amount of power. As an example, a ten-car train of the new lightweight coaches weighs no more than a seven-car train of the type of equipment built 20 years ago and, particularly at high speeds, it offers the advantage of a decidedly lower wind resistance. The

lighter cars, due to their weight advantage and better truck and brake equipment, can be started easier, accelerated more rapidly and stopped in shorter distances. Because of better insulation and more efficient heating systems the problem of heating in cold climates has been simplified and has resulted in economies.

We have now had sufficient experience in this country with the new equipment to suggest that the time has arrived when any program involving substantial expenditures for the modernization of old equipment should be very carefully weighed against the operating economies of new equipment plus the potentialities of increased passenger business because of the installation of such new equipment.

Fifteen Years of Diesel Progress

The close of the year 1939 witnessed the end of a period of 15 years since the Diesel-electric locomotive first was placed in active service on a railroad in the United States. Several interesting facts in connection with the installation of this type of power are worthy of mention.

The Diesel-electric first took its place in the switching field and, from the beginning, has continued to make rapid and substantial progress. Ten years went by before the first road locomotive was placed in active main-line service in 1935 and by that time 113 switchers, having an aggregate of 47,600 engine-horsepower, were doing their regular turn of duty.

It is interesting to note, at this point, that in 1925, when the first Diesel-electric unit went into regular service on the Central Railroad of New Jersey, there were 10,702 steam switching locomotives on Class I roads having an aggregate of 361 million pounds tractive force. During the five-year period from 1925 to 1929, inclusive, the ownership decreased by 286 units while 729 new steam switchers were ordered. In the next five-year period, from 1930 to 1934, inclusive, the ownership of steam switchers decreased by 1,704 more while only 118 new units were ordered. Thus in 10 years the ownership of steam switchers decreased by almost 2,000 during a period when the Diesel-electric was coming into the railroad picture.

At the end of 1934 there were 8,712 steam switching locomotives in railroad service and, as previously stated 113 Diesel-electrics has been placed in service. By the end of 1939 the number of steam switchers had decreased by 1,088 more to a total of 7,624 while the number of Diesel-electrics had increased to a total of 601. The total engine horsepower of the Diesel engines in switching-locomotive service was 397,380 at the end of 1939. The orders for steam switchers during the same five-year period totalled 93.

During the five-year period from 1935 to 1939 inclusive the Diesel-electric locomotive not only continued its invasion of the switching field but it also entered road service in the handling of the high-speed trains.

The installations of Diesel-electric passenger locomotives during the last five-year period totalled 73 units having an aggregate of 178,700 Diesel-engine horsepower.

The average switching locomotive horsepower in the first five-year period was 450; this had increased to an average of 630 for the latest five-year period.

The figures do not include Diesel engines in rail-cars.

New Books

ENGINEERING OPPORTUNITIES. *Published by D. Appleton-Century Company, New York. 400 pages, illustrated. Price, $3.*

"Engineering Opportunities," edited by R. W. Clyne, is a non-technical survey of engineering activities in industry. It is intended to assist young men who contemplate entering the field of professional engineering, as well as engineering students who need advice on choosing the particular business in which to apply their technical training, and shows some of the opportunities which exist today in such fields as the aluminum industry, Diesel power, electrical manufacturing, metallurgy, railway equipment, refrigeration and air conditioning, mechanical vibrations, etc. Each of the twenty-six chapters has been written by an engineer who endeavors to show the background of the industry in which he is an expert, the present condition of affairs, and the possibilities for the future. Among the authors are S. K. Colby, vice-president, Aluminum Company of America; James Shelby Thomas, president, Chrysler Institute of Engineering, Detroit, and Clarkson College of Technology, Potsdam, N. Y.; T. C. Johnson, General Electric Company, Schenectady, N. Y.; Edmund Q. Sylvester, research engineer, American Steel Foundries, and L. K. Sillcox, first vice-president, New York Air Brake Company.

DIESEL ENGINES.. *By B. J. von Bongart. Published by D. Van Nostrand Co., Inc., New York. 335 pages, illustrated. Price $4.00.*

This book is designed primarily as a text for the study of internal combustion engines of the Diesel or compression-ignition type, but is also useful to the layman who wishes to become familiar with this prime mover. After a brief history of the Diesel engine, the author discusses thermodynamics, combustion and combustion-chamber design, fuel oils, fuel atomization, fuel pumps, and injection systems. Research work, especially that relating to fuel atomization, combustion, and combustion-chamber design, is summarized. Examples of the various types of Diesel engine construction are reviewed in detail. These include aircraft, automotive, marine, and locomotive Diesels, which are representative of modern practice, particularly those in the medium- and high-speed field. A study is also made of design features in which the author points out desirable and undesirable characteristics.

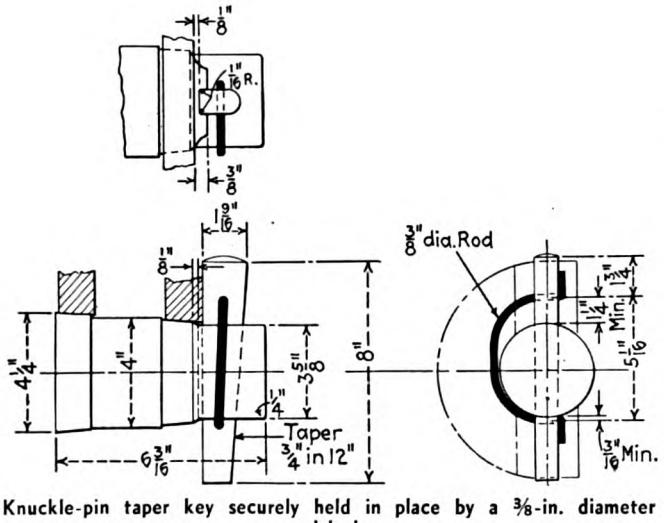
Two Safety Features In Rod Design

For modern high-speed locomotive operation, there is a strong urge to make the valve-motion parts and particularly the pistons, piston rods, crossheads and driving rods just as light in weight as possible, consistent with the requisite strength. With highly stressed steel, often containing a high percentage of various alloys, experience has demonstrated time and again the absolute necessity of utilizing rounded corners, generous fillets and highly polished surfaces free of hairline cracks, hammer marks, accidental contact with either the electric or gas-welding torch, or in fact, any surface defect which may lead to progressive fracture and failure of the steel.

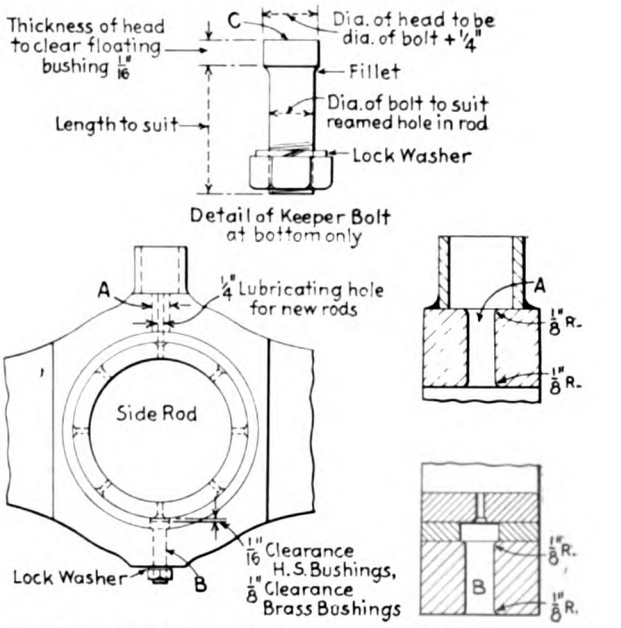
With a view to securing maximum reliability in the service of locomotive driving rods, for example, it is now considered questionable practice to cut threads in any part of the rod structure. Even threaded lubricator plug holes or keeper stud holes are looked on as possible points of danger, and a means successfully used on the Chicago, Rock Island & Pacific, for avoiding the use of threads at these two points in both main and side rods is shown in one of the illustrations. The other illustration shows a very simple but effective device, which gives positive assurance that the taper key cannot be lost out of side-rod knuckle pins and this design contributes to safety in high-speed operation.

Referring to the first drawing mentioned, the lubricating hole *A* which was originally tapped, is simply reamed out enough to remove all threads and leave a smooth inside surface with the upper and lower edges of the hole rounded to ⅛-in radii, as shown. On new rods of this type the lubricating hole is made smaller, being only ¼ in. in diameter and also having rounded edges at the top and bottom.

In the bottom of the intermediate side rod and also in the bottom of the solid back-end main rod, reference to the drawing will show that the threaded hole *B* is reamed to a smooth hole, the edges rounded to ⅛-in. radii and a keeper bolt *C* applied from the inside, with a cylindrical head positioning the bushing and a lock washer and



Knuckle-pin taper key securely held in place by a ⅜-in. diameter rod lock



Detail of side-rod lubricating hole and keeper bolt without threaded connection in the rod

hex head nut on the outside, holding the bolt securely in place. The hole in the bushing which accommodates the head of this keeper bolt is drilled ¼ in. larger in diameter than the reamed hole and the head of the keeper bolt is machined to fit accurately in the bushing hole, with a clearance of 1/16 in. under Hunt-Spiller bushings, or ⅛ in. under brass bushings. The keeper bolt is made a very light drive fit in the reamed hole *B*, the length of the bolt being made to suit the thickness of the rod at this point with just enough additional length to accommodate the lock washer and hex nut.

Referring to the knuckle-pin drawing, it will be observed that in this instance the taper holding key is 8 in. long and has a taper of ¾ in. in 12 in. In applying this knuckle pin, a draw key is used to pull the knuckle pin in place, then being removed and replaced with the taper key illustrated. It was formerly the practice to drill a hole where the narrow part of the tapered key projects through the knuckle pin and apply and spread a cotter pin which presumably would hold the key permanently in place. In actual practice, however, it was found that the taper key sometimes became loose, the cotter worked out or was sheared off and in at least one instance, the taper key itself broke inside the knuckle pin, allowing the lower portion with the cotter to drop out and permitting the upper part of the key also to become dislodged and cause a rod failure.

A simple expedient to overcome this difficulty consists of inserting the ⅜ in. diameter rod lock through the upper hole in the taper key, bending the rod around the knuckle pin and passing it through the lower cotter pin hole, and bending over each end of the rod lock as shown in the drawing. A substantial lock for the key is thus provided which cannot work loose or shear off and in the event of breakage of the taper key inside the knuckle pin, the two parts of the key will actually be held in place until the locomotive reaches the shop and suitable repairs can be made.

About Press Fits

By A. D. Hollis

In spite of the large amount of research and experiment that have been devoted to this subject new discoveries are often made and all is not known yet about press fits. For example, only a few years ago photo-elastic studies with polarized light showed that stresses were relieved by machining a groove around the hole that receives a forced-fit shaft. This practice has been tried with good results on locomotive crossheads. A groove about ⅜ in. deep and ¾ in. wide (often smaller at the bottom) is cut in the crosshead face at the same time the hole is bored. The diameter of the inside of the groove is about 1½ in. larger than the large end of the hole in the crosshead that receives the tapered piston-rod fit. In the past a great deal of trouble has been experienced with heat-treated piston rods developing small checks and cracks in the taper fit near the point where the rod enters the crosshead, often just inside the fit. These cracks propagate rapidly and eventually cause failure. It is believed that the groove mentioned will greatly increase the life of the rod.

Another interesting recent discovery (set forth in reports of the Timken tests) is that finishing axle wheel seats by rolling will lengthen the axle life by retarding the formation and propagation of fatigue cracks.

Good common sense is not a reliable guide in connection with press fits, but it has been observed that the fit allowance on axle fits is about .0015 in. for each inch of diameter and tonnage may be estimated at 10 tons for each thousandth tight (steel wheels). The tonnage for locomotive driving axles on different railroads ranges from 155 to 200 tons, depending on the diameter of the axle and local practice. The tonnage necessary to start the axle out of the fit after long service may be from 25 per cent to 300 per cent greater than the mounting tonnage. About .004 to .005 in. increase takes place in the wheel bore after a wheel is dismounted, and is greatest toward the inside of the wheel. The most abrupt taper is about 1¼ in. from the hub face. The axle diameter is not reduced due to abrasion of the wheel fit, and the axle wheel fit remains straight and round after being pressed out of the wheel. To get the specified tonnage on lightweight disk-type locomotive driving wheels, fit allowances up to .022 in. are necessary. This is .004 to .005 in. more than allowed on spoke wheels of usual hub section.

Boiled linseed oil mixed with white lead to the consistency of thin paint is the common lubricant for press fits, but some railroads use red mineral paint thinned with boiled linseed oil. Castor oil has been suggested for a lubricant for press fits. If the lubricant is allowed to stand several hours on the fit before mounting the tonnage will be reduced. Pressing out the axle and then pressing it in again may increase the tonnage. Cases have been known where workmen placed emery dust in the lubricant to increase the tonnage. Shrinking pins in wheel centers by the use of fire causes corrosion and often freezing of the pin in the wheel. Pressure up to 1000 tons on the ram will not start out some of these pins applied in enginehouses. Scoring is often caused by not properly squaring up the parts in mounting.

A shrinkage method using dry ice or liquid air, and heating the wheel with steam has promising possibilities. A similar method is used in connection with the manufacture of ordnance.

One of the largest railroad systems uses a step fit on main crank pins. This permits entering the pin freely half way in the hole and is some help in aligning the eccentric crank keyway as on a full length press fit it may swing around slightly. With a step fit there is less abrasion and a better fit is secured. Step fits on pins and axles have not been generally adopted, but railroad mechanics are familiar with the step fit (sometimes triple fit) used on cylinder bushings.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Calculating the Area Supported by Staybolts

Q.—Does the method of determining the diameter, and area supported by a hollow rigid staybolt also apply to a hollow flexible staybolt?—F. R. J.

A.—The area supported by either a hollow rigid or a hollow flexible staybolt is computed from the same formulas, the differences in the construction of the staybolts does not affect their respective holding powers.

Determine the maximum pitch of water space staybolts by the two methods given below and use the minimum valve thus obtained.

(a) Do not exceed a maximum stress of 7,500 lb. per sq. in. of net area, when staybolts are made of iron. In calculating the stress use the supported area less the area of the staybolt at the root of the thread, multiply by the maximum pressure for which the boiler is designed, and divide by the net area of the staybolt. The net area of the staybolt means least cross-sectional area at any part, usually at the root of the threads less the area of the telltale hole, but may be at the center in case it is reduced below the bottom of the thread.

(b) Do not exceed the maximum pitch as provided in the following A. S. M. E. Boiler Code Formula:

$$P = C \times T^2/p^2$$

where P = maximum allowable working pressure, lb. per sq. in., C = 125 for plates 7/16 in. thick and under, and 135 for plates over 7/16 in. thick, T = thickness of plate in sixteenth of an inch, and p = maximum pitch, in inches.

Suppose we have given a hollow rigid staybolt of 1 in. body diameter, 1 1/16 in. end diameter, 12 U. S. F. threads per inch and 7/32 in. telltale hole diameter. Also, a hollow flexible staybolt of 1 in. body diameter, 1 1/16 in. diameter end, 12 U. S. F. threads per inch, and 7/32 in. telltale hole diameter with 1⅜ in. diameter head, and suitable sleeve and cap. The thickness of the firebox sheet is 7/16 in., and the maximum boiler pressure is 250 lb. per sq. in.

Substituting in (a) for either type staybolt we have the net cross-sectional area of the staybolt through the body, minus the area of the telltale hole = .7479 sq. in., net cross-section area of the staybolt at the root of the thread, minus the area of the telltale hole = 0.6775 sq. in.

The load carried by one staybolt is $0.6775 \times 7{,}500 = 5{,}181$ lb.

The area supported by one staybolt is $5{,}181 \div 250 = 20.7$ sq. in.

The total area supported by one staybolt is $20.7 + .7150 = 21.415$.

The maximum pitch of staybolts is $\sqrt{21.45} = 4.63$ in.

Substituting in (b) for either type of staybolt, we have:

$$P^2 = C \times T^2/P = 125 \times (7)^2/250 = 20.45$$

There, the maximum pitch of the staybolts $p = 4.52$ in.

From the above the maximum pitch of either the hollow rigid or the hollow flexible bolts would be 4.52 in. The diameter of the staybolt can be obtained from the formula in paragraph (*a*) when the working pressure and the pitch of the staybolts is known. The design of flexible staybolt sleeves is such that the cross-sectional area of the sleeve is always greater than the least cross-section area of the staybolt.

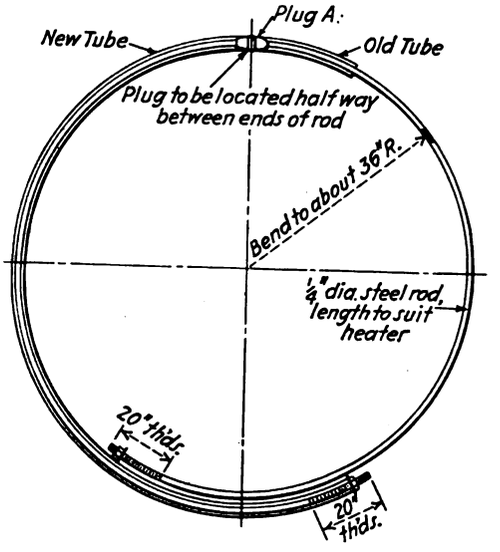
How to Renew Tubes in a Coffin Feedwater Heater

Q.—How are the tubes in a Coffin feedwater heater renewed? —M. T.

A.—The tubes in a Coffin feedwater heater are replaced by the use of the tube removing device shown in the drawing. It consists of a ¼-in. diameter rod, rolled to a 72-in. radius and of sufficient length to hold both the new and old tube. A stop or plug is welded on the rod at the middle, the outside diameter of the plug being made of sufficient diameter so as not to pass through the tube but small enough to pass through the tube-sheet hole.

To renew a tube, it should be drilled out of both tube sheets, after which one end of the tube remover is inserted in and threaded through the tube until it projects out at the opposite end. A nut is then applied on the protruding end. This nut is tightened until the stop on the tube remover is tight against the opposite end of the tube.

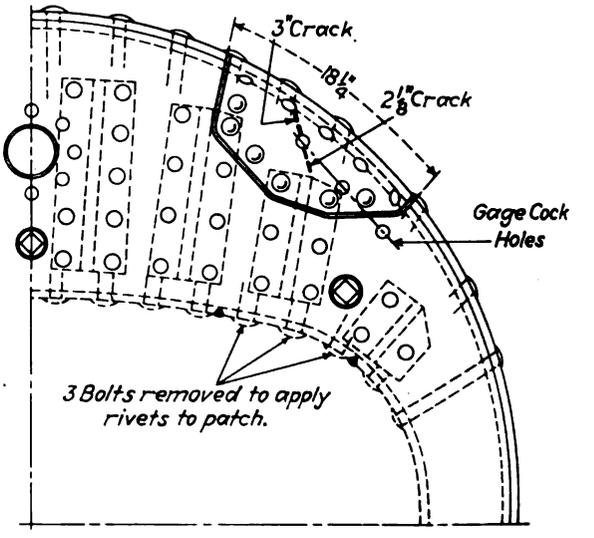
The opposite end of the tube remover is then inserted into the new tube in the same manner. The tube remover is notched until the old tube is removed and the new tube is in place. Afterwards remove the tube remover from the new tube and roll the tube ends into the tube sheets with a ½-in. tube expander.



Device for replacing Coffin feedwater-heater tubes

Boiler Patch Applied to Back Head*

The diagram shows the location of cracks which developed in the radius of the flange at the top of the back head of a locomotive. The cracks were electric welded after which a patch was applied as indicated on



A section of the crown sheet was removed to permit the holding of the rivets in applying this patch to the back head

the diagram. The patch was fabricated from ½-in. steel plate, riveted with ⅞-in. rivets, and electric welded to the outside wrapper sheet along the top of the boiler.

The application of this patch presented a problem which was solved in an economical manner. Instead of removing three rows of crown bolts the entire length of the firebox to permit the holding of the rivets from the inside, only the three crown bolts indicated on the diagram were removed. Then, a 4-in. by 12-in. section of the crown sheet was removed by use of a cutting torch. The patch being well above the crown sheet made it very difficult to hold the rivets through the small hole made in the crown sheet. A bar was designed especially to hold the rivets at the various angles. After the application of the patch was completed, another patch was welded in the opening in the crown sheet.

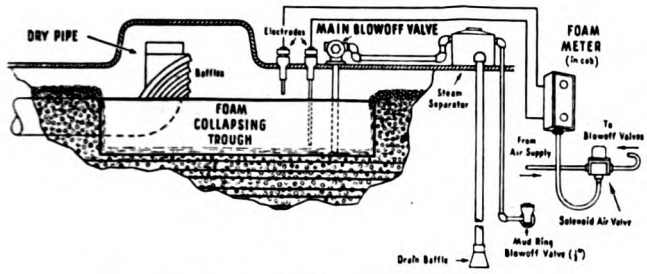
* An entry in the prize competition on boiler patches, announced in the March, 1939, issue. The names of the winners were published in the August, 1939, issue.

Automatic Blow-Off System

The Electromatic Foam-Collapsing blow-off system is designed to prevent the carrying over of water to locomotive cylinders and to reduce blow-down losses. It is a development of the Electro-Chemical Engineering Corporation, subsidiary of the Dearborn Chemical Company, Chicago.

The system utilizes: (1) A foam-collapsing trough which is mounted rigidly in the locomotive boiler directly under the dry-pipe intake; (2) a long electrode and a short electrode which project into the trough; (3) a solenoid valve; (4) a Foam-Meter; (5) two blow-off valves, and (6) a steam separator and drain.

When the boiler water expands to a dangerous point,



The Electromatic Foam-Collapsing blow-off system

it spills over into the trough. Here the foam is collapsed and the water in the trough makes contact with the long electrode. This lights the "safe" lamp on the Foam-Meter in the cab, and at the same time operates the solenoid valve which, in turn, opens both blow-off valves. Thus, the water in the trough, which contains a large proportion of the floated suspended matter, is blown down. Water and sludge are also blown from the mud ring through a smaller blow-off valve.

This system is designed to prevent water carry-over under practically all conditions by maintaining a clear steam passage to the dry pipe. It is said to prevent blow-off losses because it blows only when necessary, i. e., when the water expands to a dangerous level. It is fully automatic in operation and is designed so the engineman can always utilize the full steaming capacity of the boiler and will not have to ease off on the throttle or shorten the cut-off.

Spray Gun for Decorative Finishing

The type AG spray gun, a product of the DeVilbiss Company, Toledo, Ohio, supplies a range of service from the drawing of a fine pencil line to the laying of a broad soft spray and bridges the gap between the large artist's air brush and the small production or touch-up spray gun. It is especially suited for delicate tinting, fine stenciling, shading, blending, and high-lighting.

This spray gun is strongly built and at the same time is light in weight. It fits the hand easily, permitting the forefinger to rest naturally upon the trigger of the gun for ready control. It is available with a choice of three nozzle combinations which are adjustable for either round or spray applications. The gun offers a maximum spray width of three inches with accurate and simple control of both the width and density of the spray.



The DeVilbiss type AG spray gun

Whiting Drop Pit Table

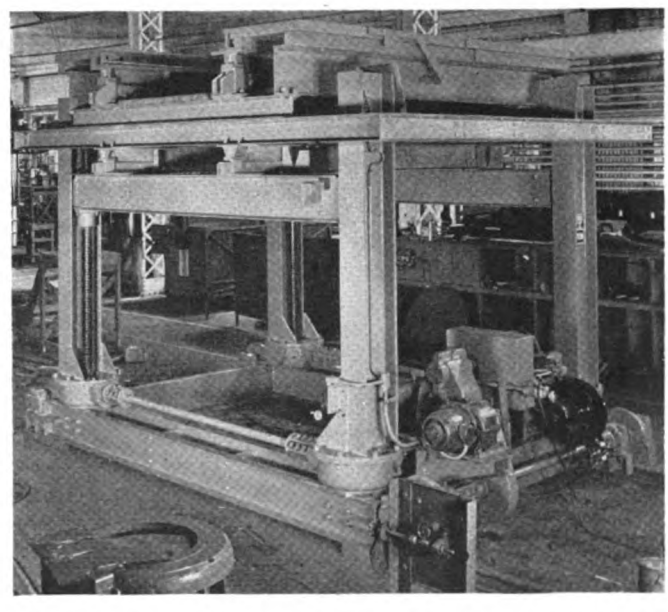
The new Whiting 60-ton Type B drop-pit table has recently been installed on the Green Bay & Western, at Green Bay, Wis. The machine operates in a pit serving two active tracks with a release track between. A single shoulder pit serves one active track and the release track, with Whiting self-supporting swing gates for this active and release track. The remaining active track is not equipped with a shoulder pit or gates.

Each active track is equipped with a tabel top. Wheels may be dropped on either top and complete trucks may be dropped on the active track equipped with the shoulder pit and gates. All equipment dropped can be released at the releasing track.

The layout was arranged to handle individual pairs of wheels and complete trucks from steam and Diesel-electric locomotives, as the road uses both types of power.

Like other standard installations the space over the pit between the two table tops is equipped with a large platform spanning the pit. Unlike other installations, however, this particular platform is equipped with locking bars and pockets.

Before starting wheel-dropping operations, the machine is brought under this platform. After its bars are released it is lowered, moved under a table top and raised to nested position, as shown in the illustration. The load is lowered on the table top which, in turn, rests on the platform. After the load is racked sidewise, raised to the release track and wheels released, the top is brought back to its original position and the platform again locked in place between stalls.



Model B 60-ton drop-pit table with steel platform, usually located between table tops at ground level, nested against the table top

With the Car Foremen and Inspectors

Centralia Car-Shop Kinks

A RAILROAD shop is known and its efficiency largely determined by the number and quality of labor-saving machines and devices which are used to reduce manual labor and expedite output. Shop kinks are just as important in car shops as in shops devoted to locomotive repairs, and a considerable number of those developed and used at the Illinois Central car shops, Centralia, Ill., are illustrated and described in the following pages.

Straightening Car Parts

Wherever possible, steel car parts which have been bent in service are straightened without removal from the car body, using pneumatic devices to save manual labor. For example, hopper-car doors which were formerly removed for repairs are now straightened in place using a quick-acting pneumatic jack under the center of one side sill to tip the car enough for a short steel bar to be placed between substantial blocking on the shop floor and the part of the hopper door which has been bent down due to excessive loading or damage from the clam-shell bucket. By lowering the air jack, the weight of the car body is used to press out the bulge and straighten the door, also closing all openings around the door except possibly a few which may be so large as to require individual attention.

This operation may be repeated almost as fast as the air jack can be operated and, as compared with the former method of removing the doors for straightening and then trying to fit them back up again, with hinges and fixtures somewhat out of alinement, a vast number of man hours of labor are saved every year.

Similarly, in the case of the bulged car ends, the end sheets can frequently be straightened in place by chaining the damaged car to another car with the coupler faces about 6 in. apart and using a double-acting air cylinder with special attachments to push against one car end while straightening the one which is bulged. In this operation, an 18-in. air cylinder is suspended from an overhead crane at the proper elevation between the cars. Both the moving piston rod and a rod of the same size, bolted to the pressure head of the air cylinder, have 24-in. swiveling steel bars on the ends, one being placed vertically against the straight car end to give a large bearing area and the other fitting in a horizontal corrugation of the damaged car end at the point of maximum bulge. One or more applications of air pressure are made, as necessary to straighten the end.

Referring to Fig. 1, a gantry crane and air-operated device for straightening the top rails of hopper and gondola cars will be seen. This gantry crane is a welded structure, made essentially of 9-in. channels, suitably braced and mounted on four 17-in. flanged wheels, thus being capable of movement on rails to any point desired along the car. The supporting rails are spaced 14 ft. on centers. The gantry is 14 ft. high, the spread of the wheels on each rail being 7 ft. 3 in., and a double 3-in. angle-iron runway at the top is equipped with one-ton chain falls which support the air-operated device used in straightening the top rails.

After a heavy-repair steel car has been stripped of defective plates and parts, the last operation before sending it to the sandblast position is to place it under the gantry crane, illustrated, for straightening the top rails. Small kinks are straightened cold, but, if too badly bent, the rails have to be heated slightly with a torch. The straightening device is a 12-in. air cylinder, equipped with a yoke on the pressure head and two hooks which are applied over the top rail, the air-cylinder piston rod contacting the top chord angle at the point of maximum deflection. Just enough pressure is applied in the air cylinder to remove this kink in the top chord angle, which is straightened progressively as needed by moving the gantry crane along the side of the car.

A satisfactory straightening job can thus be done without the expensive operation of removing, straightening and reassembling these parts. The hooks which reach over the top chord angle are provided with lips to prevent slipping and the steel block on the piston rod end is grooved to fit over the flange of the angle, thus holding the block in place while pressure is exerted against the web during the straightening operation.

In applying new sheets to steel cars, various types of lifting devices and special hooks are used to permit putting the sheets in place ready for riveting with a minimum amount of hand labor and with maximum

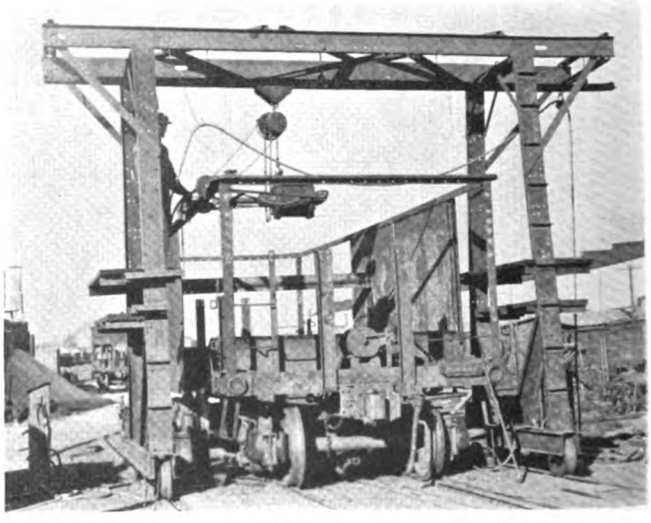


Fig. 1—Gantry crane equipped with air-operated device for straightening hopper-car top rails

safety. Two lifting hooks, illustrated in Fig. 2, are made of ½-in. by 3½-in. welded bars with the lower end of each vertical bar bent in the form of a flat hook to extend around the lower edge of the sheet and drilled with a hole through which a bolt may be applied to hold the sheet against slipping. The vertical bars are separated by substantial cross pieces and have chain connections at the top to a common ring which engages the crane hook. When lifted with the crane, this hook suspends the sheet above the center of gravity and hence it may be easily moved to the car, hoisted in place and holding bolts applied through the upper rivet holes without manual labor or the danger of pinched fingers.

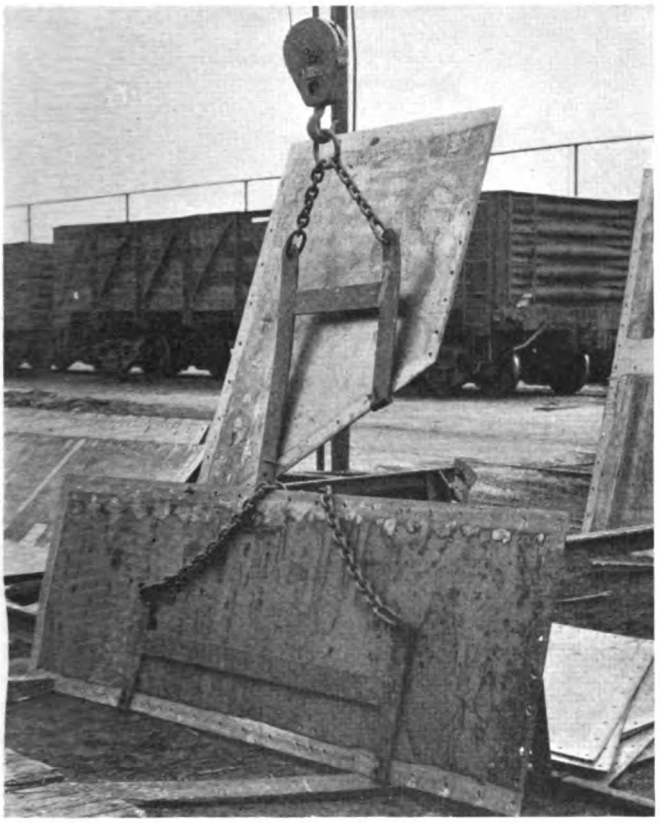


Fig. 2—Lifting hooks used in applying steel car sheets of various shapes easily and safely

It will be noted that the lower lifting hook, shown in the illustration, is designed to assist in the application of rectangular sheets like the end sheets of a hopper car. The upper lifting hook is used in applying corner sheets which are irregular in shape and would be difficult to handle by any other means. If lifted by the crane with a chain connection to one of the upper rivet holes, for example, the chain would have to be released before the sheet could be finally pushed up in place by hand and holding bolts applied. The great advantage of these special hooks which permit lifting heavy sheets from the bottom by a crane is obvious.

Safe-Ending Hopper Car Doors

Almost every railroad shop man knows what is meant by safe-ending a boiler flue but how many realize that it is also possible to safe-end a hopper car door. In safe-ending boiler flues, defective ends are simply removed and new ends welded in place to give the flues another period of effective service. That is exactly the process involved in safe-ending hopper car doors as now practiced at the Centralia car shops. The lower edges

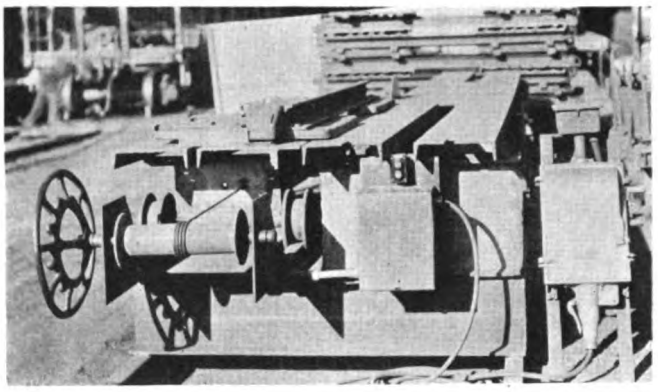


Fig. 3—Cold saw used in cutting off the worn ends of hopper-car doors preliminary to "safe-ending"

of the doors become eaten away by corrosion and mechanical wear until they are no longer tight and strong enough to carry a commodity load. Pressed-steel doors have a relatively short service life in this particular and even cast-steel doors show evidence of corrosion long before the car body is worn out.

When the practice of renewing these door ends was first instituted at Centralia, a section of the lower edge of each door about 3 in. wide was cut away, using an oxy-acetylene cutting torch. A new steel end was fabricated from a ¼-in. copper-steel plate, being made from a flat sheet of steel, flanged, cut out and welded at the corners so as to form a duplicate of the section of the door which was cut away. The difficulty with this method was that, even with the greatest care, a somewhat irregular edge was left by the cutting torch and in welding the new end back on the door, some difficulty was experienced. To overcome this trouble, a cold cut-off saw, shown in Figs. 3 and 4, was developed which performs the cutting operation in a fraction of the time formerly required and leaves a straight, smooth cutting edge to which it is easy to fit the new safe-end and weld it securely in place.

The cold saw consists essentially of a stationary table with a 24-in. metal-cutting saw mounted at the center and driven at a speed of approximately 1,200 r.p.m. by

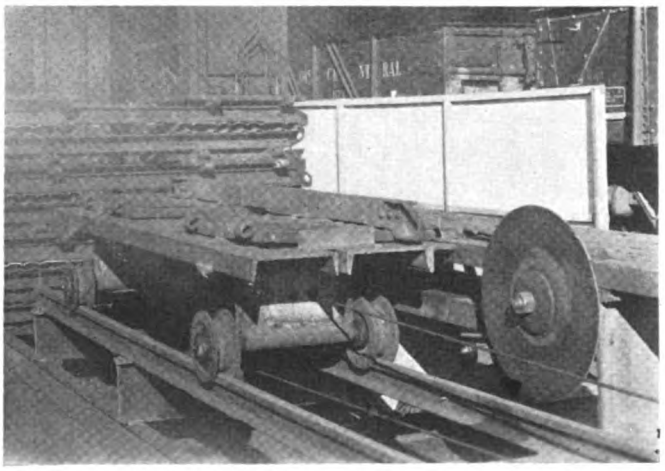


Fig. 4—Another view of the machine showing details of the door carriage and cut-off saw

belt drive from a 10-hp. motor mounted under the saw table. The saw blade is $\frac{3}{16}$ in. thick and the teeth in the outer periphery are designed to cut light sheet metal quickly and without excessive wear. The stationary

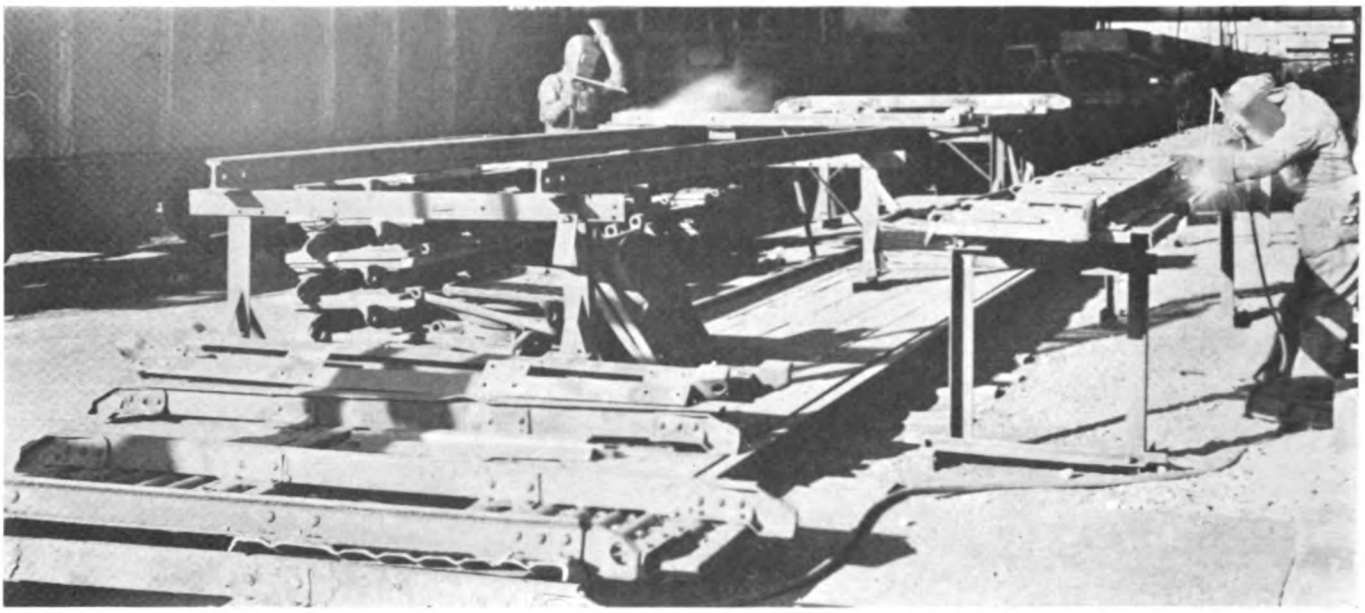


Fig. 5—Assembly lines in which new doors are fabricated and old doors equipped with new ends

table of the machine, best shown in Fig. 3, consists of two 12-in. by 20-ft. channels resting on and welded to four pairs of cross channels, the lower ones extending across the rails and being tack-welded to them. Two lengths of 90-lb. rail, 20 ft. long, rest on the lower channels and serve as a support for the traveling carriage which is mounted on wheels and arranged to support the hopper car door while being cut. The carriage is a welded steel structure comprising two 12-in. channels 10 ft. long, mounted on a frame which carries the roller wheels and equipped with positioning stops which hold the door both longitudinally and crosswise so that a straight cut will be taken 3 in. from the lower edge of the hopper-car door.

The carriage is traversed by means of an endless steel cable applied over an idler wheel and a 5-in. by 18-in. drum with hand wheel attachment as shown at the left in Fig. 3. Push-button control is provided for this machine and also a Pyle-National safety switch mounted on a portable steel framework as shown at the right. Referring to Fig. 4, a view of the machine is given with the door carriage at the extreme end of its travel after a cut has just been made.

Referring to Fig. 5, two assembly lines are shown inside the shop. The one at the left is used for fabricating new hopper-car doors and the line at the right for reconditioning old doors by applying new ends. Both of these assembly lines for car doors are placed opposite the position in the shop where hopper-car doors are applied and thus additional door handling is obviated with this arrangement.

In the operation of safe-ending, a new hopper door end, made of ¼-in. copper-bearing steel, is tack welded in place on each door down the entire length of the assembly line. One or more welders, as required, then complete the longitudinal welds using the electric process. The corners are formed by bending the ends 90 deg. and welding them to the doors which are then ready for

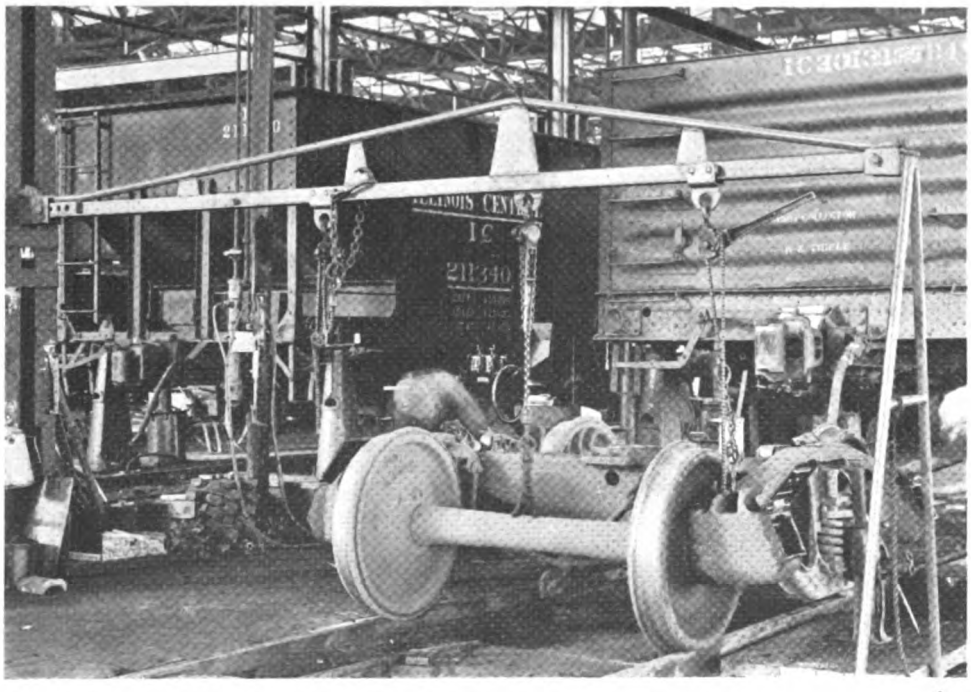


Fig. 6—Counterweighted truck-dismantling frame which may be swung upward against the vertical steel column when not in use

re-use with the probability that they will last throughout the life of the car.

Reduced Labor in Truck Work

Since truck repairs constitute an important part of car-shop work, every effort has been made to provide the special tools and equipment necessary for the expeditious handling of this work. A considerable number of frames for dismantling trucks, for example, are installed where needed throughout the shop, being in general of three types. The frame, illustrated in Fig. 6, is a light but well-braced beam, hinged to one of the steel building columns, having a hinged A-frame at the outer end and connected by a steel cable and pulley to a counterweight which operates vertically in the building column and permits easily swinging this dismantling frame up against the column when not in use. This type of dismantling frame is used adjacent to passageways where space is at a premium and crossovers must not be blocked. A somewhat less expensive dismantling frame, of the same general construction and also hinged to the building column, but arranged to swing horizontally parallel to the tracks is used where space is available.

The third type of truck-dismantling frame is a more or less permanently-positioned 8-in. I-beam which extends at an elevation of about 8 ft. high across the track at the major truck-repair station and does not have to be moved since this position is devoted exclusively to the repair of trucks and does not require the passage of cars along the track at any time. The beam is equipped, as usual, with three horizontally-adjustable hoists for handling the bolster and two side frames of a truck simultaneously. Such a permanent beam is shown in the background of Fig. 7.

In the foreground of this view is one of the large jib cranes, having a 19-ft. I-beam and equipped with a powerful and fast-operating air-hoist. An overhead electric hoist which travels on an 87-ft. I-beam across the heavy repair shop at this point provides means for transferring the trucks between the truck-repair position and any track on that side of the shop.

Referring again to Fig. 7, the special arrangement of crane hook used in lifting assembled trucks is shown. The construction of this steel frame with the four chains connecting to a single ring for attachment to the chain hook is clearly illustrated. A particular advantage of the device is that the four 1⅛-in. round bars which are bent in a half circle at the bottom for engagement with the car axles are hinged at the top so that when not in use they can be swung upward to a position slightly past the vertical while the frame is resting on the shop floor or being removed about the shop from one track to another. When positioned above the truck to be moved, the hooks are simply given a little push and swing down by gravity to the position shown in the illustration. Operation of the crane then lifts the truck without any possibility of the car brasses and wedges slipping out of position as is the case when ordinary chain hooks are used to engage the side frames or bolster.

Painting Underframes With Car Cement

When any attempt is made to spray car cement on the underframes of cars on the repair track, it is difficult, and in fact almost impossible, to reach all parts of the underframes, including inaccessible corners between the sills, bolsters, cross bearers, etc., unless the painter actually gets down on his hands and knees and crawls under the car. To permit doing a more thorough underneath-spraying job in less time, Centralia is equipped with two spray pits, one of which is shown in Fig. 8. This pit is 15 ft. wide by 61 ft. long and slightly over 5 ft. deep. The rails are carried across the pit on 18-in. I-beams, welded to supports which are made of 9-in. channels. A wooden platform on either side of the pit, 22 in. high enables the painter to work on two levels, whichever is easier, and access to the pit is had by means of steps at each end of each platform. A 3-in. angle-iron guard rail 28 in. high is provided on each side of the pit as a safety measure.

This pit, used for painting the under parts of all cars passing through the shop for heavy repairs, makes it easy to reach hitherto inaccessible places and do a

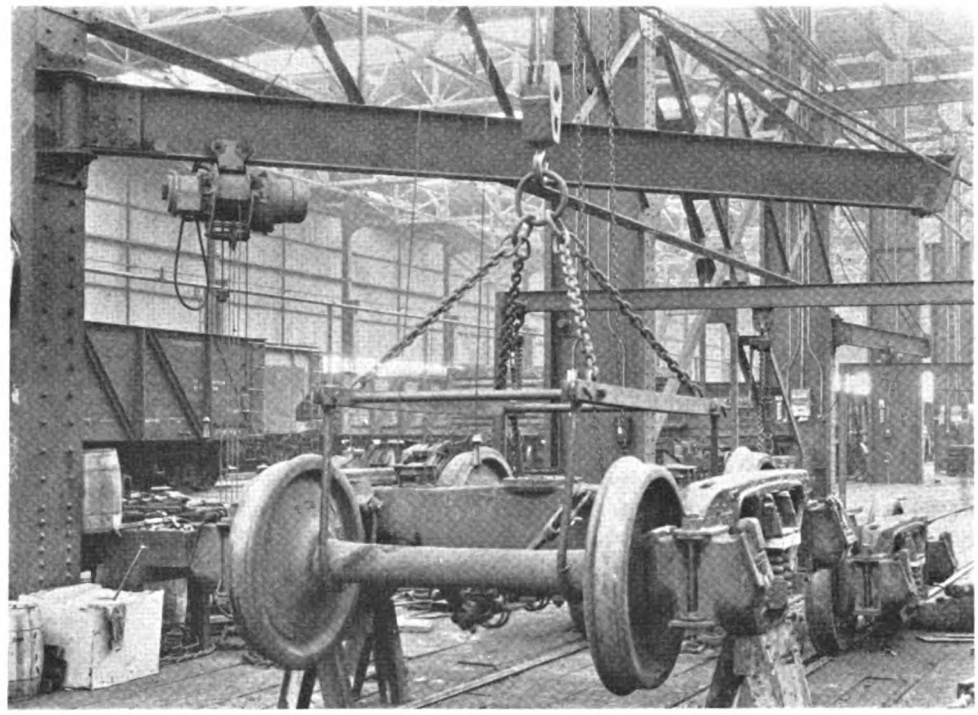


Fig. 7—Heavy jib crane, special crane hook and other devices used in the main truck assembly line

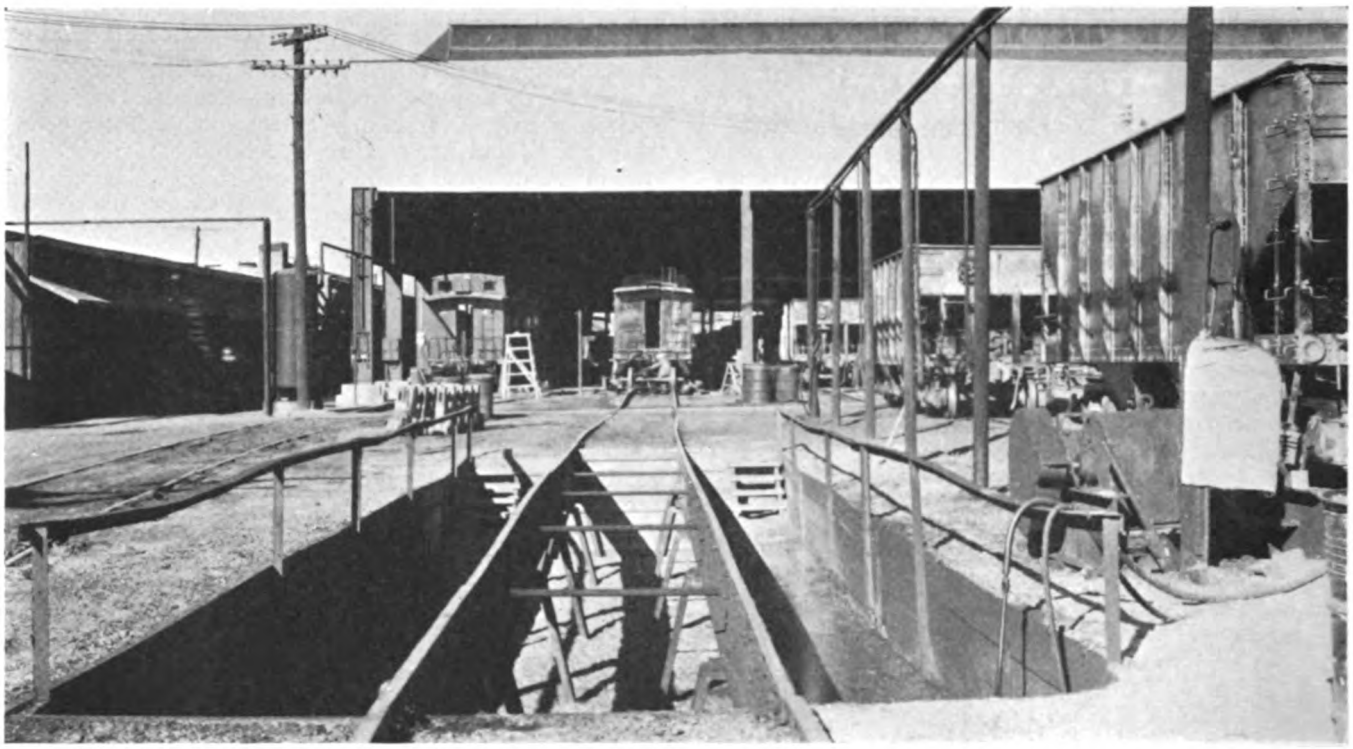


Fig. 8—One of two large pits used in spraying the under parts of cars with car cement

thorough painting job. Approximately 45 minutes per car is required for painting the complete underside, including the slope sheets of hopper cars. By former methods, a less satisfactory job was done in approximately twice the time.

The car cement used in this operation is received at the shop in 55-gal. metal drums and, to avoid loss of cement in draining the drums, especially in cold weather, the steam-heated device, shown at the right in Fig. 9, is used. This consists simply of a sheet-metal cylinder, mounted in an inclined position on a 1¼-in. angle iron framework, the cylinder being 44 in. long by 29 in. in outside diameter which is about 4 in. larger than the cement drum which is centered in it and held in place by a metal hook. Steam is piped to the cylinder and controlled by a small globe valve. When the galvanized-iron hood, illustrated in a raised position, is lowered and steam admitted to the cylinder for about 30 min., the drum is heated sufficiently so that the cement runs out by gravity and is caught in a paint pail underneath, leaving a practically clean drum. From ½ to 1 gal. of cement per drum is thus saved, dependent upon the outside temperature.

Other parts of the cars above the underframe are also painted at this position as shown in Fig. 9. The cars after sandblasting are given a protection coat of rust preventive before being received at the painting position. One of the vertical tanks, shown adjacent to the hopper car, is an air reservoir with provision for heating the air by means of a steam coil before it goes into the larger tank which also is heated and contains quick-drying mineral black paint used as the final coat on hopper cars. The paint is thus kept in a fluid condition and satisfactory for the quick and satisfactory spray painting of the car bodies, regardless of outside temperatures.

Car-Brass Trimmer

Referring to Fig. 10, a car-brass trimmer, furnished by the Journal Box Servicing Corporation, Indianapolis, Ind., is shown. This machine consists of a small double-head hand-operated shaper with special chuck for holding the brass and having cutter heads and tools with cross and vertical hand feed as shown. The machine itself is mounted on a steel frame which is carried on two 26-in. wheels with handles on the front for convenient movement about the shop and a box on the rear which contains brasses of different size. The particular model of car-brass trimmer illustrated has a hand-operated worm gear and quadrant which permits lowering and retracting the heavy part of the machine, moving the center of gravity closer to the wheels and thus permitting easier movement of the device about the shop.

All second-hand car brasses are trimmed in this machine; babbitt runs on the sides of the brass are removed and uniform lubrication thus assured throughout the

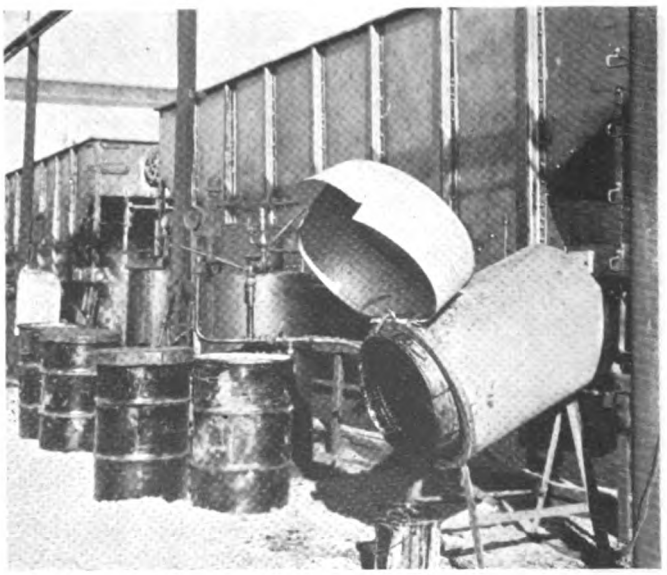


Fig. 9—Paint spray equipment and steam-heated device (at the right) used in warming drums to facilitate draining out all excess car cement

bearing. The brass is returned to the journal from which it was removed, the fit, therefore, being more accurate than with a new brass, with much less chance of a hot box developing. By this method of reclamation many car brasses are returned to service and improved performance secured.

The use of trimmed car brass is said to prevent trouble from three causes: Flow of hot oil away from the journal and bearing at the edge of the bearing; flow of oil out on the axle and wheel at the rear of the journal box; build up of lint from the oil under the babbitt overrun, shutting off the flow of oil to the journal. Such bearings, while operating at excessive temperatures and causing many failures, are not worn out, but, in fact, only properly seated and would run many years, perhaps, except for the over-run condition.

The Association of American Railroads' rules provide for the replacement of over-run bearings and tests indicate that 74 per cent of the bearings replaced are due to this cause. The same tests are said to have shown that 43.2 per cent of all bearings are in a partially over-run position, but not enough to justify replacement. The car-brass trimmer, in trimming the edges of linings and reshaping the original oil grooves where there are any,

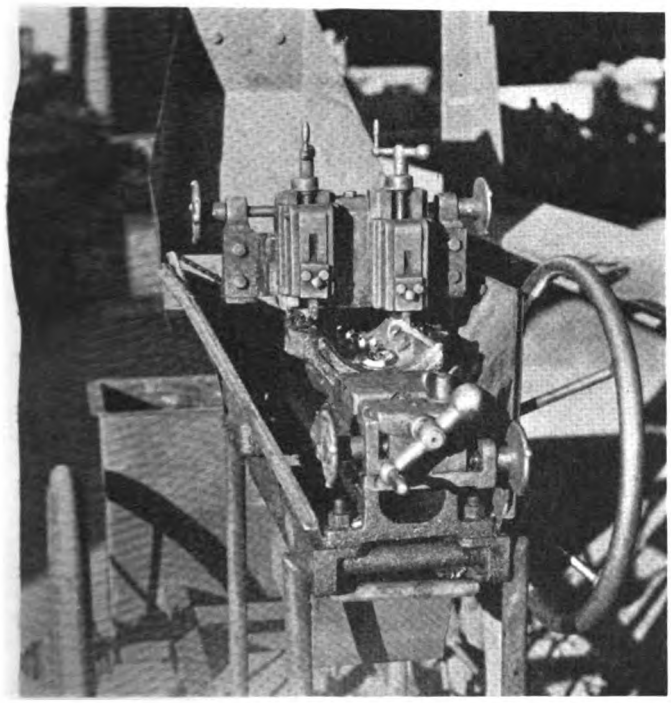


Fig. 10—Journal-brass trimmer which effects large economies by removing babbitt runs so that many brasses may be reclaimed for further service

puts brasses in condition to operate at 100 deg. F. lower temperature and saves 74 per cent of normal replacements.

The last illustration, Fig. 11, pictures a relatively simple device used at Centralia to assure the provision of cool drinking water to car men on the repair track with a minimum expenditure for ice. It consists simply of a small metal drum sunk vertically in the ground and containing at the bottom a few coils of the water supply pipe before it is connected to the drinking fountain in the upper part of the picure. The upper end of this drum has a double edge or annular ring, which is filled with water and becomes a water seal when the cover, shown in the illustration, is applied in a horizontal position. This drum is packed with ice early in the morning

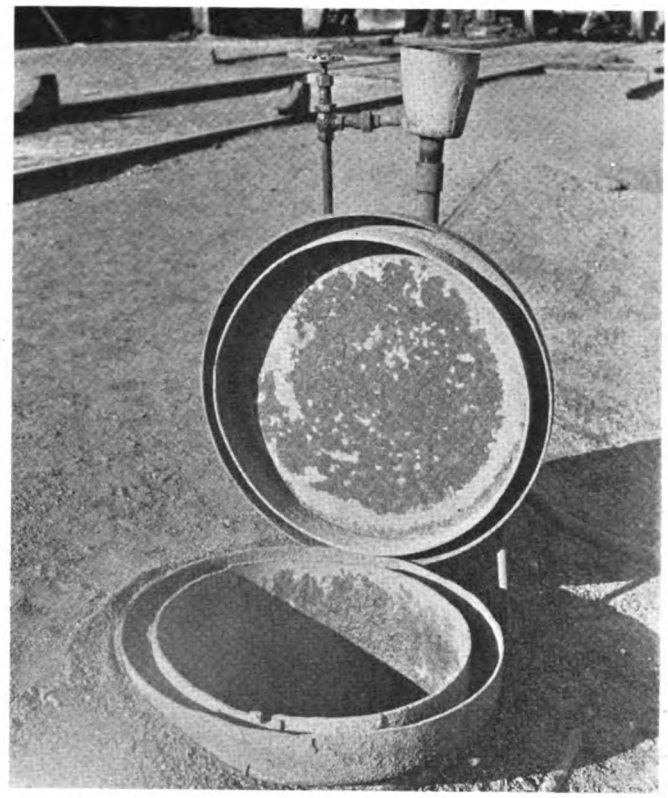


Fig. 11—Efficient device for cooling drinking water—A great boon to car men on a hot day

and even on the hottest day does not require replenishment, owing to the fact that the drum is sunk in the ground where it is not exposed to hot surface air and the cover makes a water seal which is absolutely air tight. At least one icing a day is saved by means of this device.

Air Brake Questions and Answers

D-22-A Passenger Control Valve (Continued)

510—*Q.—How is this proportion rated?* A.—It is such that on cars having the brake rigging designed for 250 per cent braking ratio with 100 lb. brake cylinder pressure, this pressure is limited by the A-4-A valve to a maximum of 60 lb., or 150 per cent braking ratio, with 100 lb. displacement reservoir pressure.

511—*Q.—How is the release spring designed?* A.—So as to produce a sufficient force to overcome resistance of the diaphragm portion in order to insure release with low brake cylinder pressure.

512—*Q.—Is this release force effective at all times?* A.—No, only with application pressure of low value.

513—*Q.—Why is it undesirable to have this spring force at all times effective?* A.—It would prevent the desired close build up of the brake cylinder pressure with application pressure in chamber *A*.

514—*Q.—What functions to balance the release spring force and diaphragm resistance when application pressure in chamber A exceeds the low pressure for which it is adjusted?* A.—Levers known as 86 and 87, diaphragm *82* and spring *93* at the right of the diaphragm assembly balance the force of the release spring and diaphragm resistance.

515—*Q.—Explain the operation with less than 5 lb.*

application pressure in chamber A. A.—The balancing diaphragm is in normal position and the lower end of diaphragm level *87* is at its extreme left-hand movement. The middle connection of this lever is fulcrumed and the upper end, which is attached to the upper end of the large balance lever *86,* is at its extreme right-hand movement. This carries the upper end of the balancing lever to the right and, as the lower end of the lever fulcrums on the balance spring *93,* the middle connection does not offer resistance to the diaphragm follower, except when the diaphragm has moved far enough to the right to insure the release valve of the self-lapping unit being open.

516—*Q.—What does this provide for?* A.—The release bias of the release spring *53* is effective in affording positive release when application pressure in chamber *A* is reduced to a low value.

517—*Q.—Describe the operation when five to seven pounds application pressure is built up in chamber A.* A.—In this case the balancing diaphragm *82* is deflected to the right. This carries the lower end of the diaphragm lever to the right, and as it fulcrums on the middle lever connection, the upper end moves to the left carrying with it the upper end of the large balancing lever. This brings the middle connection of the large lever *86* into contact with the diaphragm follower on which the lever now fulcrums, and moves the lower end of the lever to the right, picking up the force of the balancing spring. The upper connection of the large lever now becomes the fulcrum and the force of the balancing spring is transmitted through the large lever to the diaphragm follower.

518—*Q.—Is a close relation between application pressure in chamber A and that developed in the brake cylinder required?* A.—Yes.

519—*Q.—What provides for this?* A.—The force delivered by the balancing spring to the diaphragm follower is sufficient to offset the release spring bias and insure the relativity required.

520—*Q.—How can the relay valve be converted for high-speed governor control so that the diaphragms produce the proper ratio of brake cylinder pressure for a given pressure in chamber A at predetermined speeds?* A.—By removing the follower between the two diaphragms, installing two additional diaphragms with followers, and substituting a magnet bracket for the blanking flange at the top face.

521—*Q.—What does the number, size, and location of brake cylinders depend on?* A.—The weight of the car and the particular installation.

522—*Q.—How is the UA type of brake cylinder designed?* A.—To prevent the entrance of dirt and the construction is such that lubrication of moving parts without removal of the piston or opening of the cylinder is possible.

523—*Q.—How are the cylinder body and pressure constructed?* A.—They are combined into a single casting which is provided with a bolting flange for mounting and a reinforced flanged union for the pipe connection.

524—*Q.—How is the piston constructed?* A.—The piston has a hollow rod which provides for a loose push rod. This rod is attached to the levers and rods of the foundation brake rigging. A push-rod holder is attached to the outer end of the piston rod.

525—*Q.—What type of packing cup is used?* A.—A solid packing cup.

526—*Q.—How is it held in place?* A.—The perimeter of the piston head is machined to form a shoulder over which the packing cup is fitted. The cup is applied by snapping it over the shoulder.

527—*Q.—What is back of the shoulder and what does it contain?* A.—There is a groove back of this shoulder which contains a cup supporting ring and a lubricator assembly with a felt packing ring or swab. The space back of the heel of the packing cup and in front of the felt swab provides a groove around the piston which, when filled with lubricant, serves to spread the lubricant over the cylinder wall with each movement of the piston.

528—*Q.—What is the purpose of the felt swab?* A.—It serves a double purpose; prevents overflow from the groove to the non-pressure side of the piston when the lubricant is introduced, and as the swab becomes saturated with the lubricant, results in the cylinder surface being lubricated with each application and release movement of the piston.

529—*Q.—When should the piston be lubricated?* A.—When in release position.

530—*Q.—Why is this?* A.—With the piston in release position, the grease cavity aligns with four grease ports in the cylinder body which are normally plugged.

531—*Q.—How is the lubricant applied?* A.—From the outside by means of a grease gun at any one of the four connections.

532—*Q.—What provision is made to prevent the entrance of dirt?* A.—The piston rod is ground true as to diameter and surface, and the non-pressure head is fitted with a piston rod lubricator and protector.

533—*Q.—What does the protector consist of?* A.—A felt swab and three bronze rings which are packed in grease, serving to lubricate the piston rod as well as to seal the interior of the cylinder against dirt and moisture.

534—*Q.—How are the piston rod and rings lubricated?* A.—A tapped opening in the non-pressure head provides a means of lubrication.

535—*Q.—What arrangement has been made to permit admission of atmospheric air to the non-pressure end of the cylinder during the release movement?* A.—The non-pressure head is fitted with a curled hair strainer of the cartridge type.

536—*Q.—How is the strainer held in place?* A.—By a breather cover which prevents dirt and water contacting the strainer.

537—*Q.—What is the function of the automatic slack adjuster?* A.—To maintain a predetermined brake cylinder piston travel.

538—*Q.—What does the type depend on?* A.—Brake cylinder location and mounting.

539—*Q.—How many general types are there?* A.—Three. Types A, B, and C.

540—*Q.—What is each type for?* A.—Type A is for mounting on the end of truck frame; Type B is for mounting on the end of brake cylinder when the cylinder is located on the car body, and Type C is for mounting on the top or side of the truck frame.

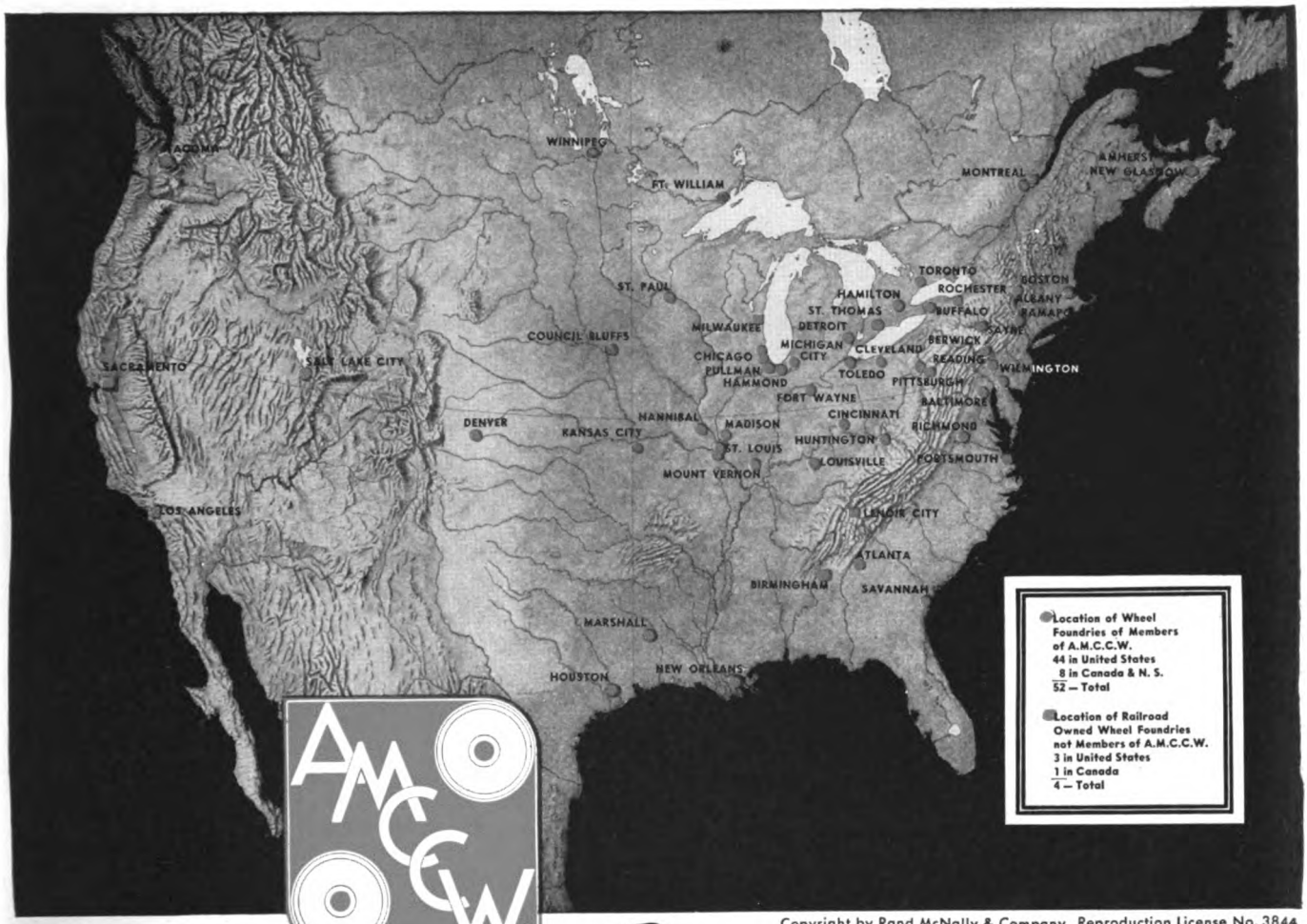
541—*Q.—Do all three types require slack adjuster lug and lever bracket on the cylinder pressure head?* A.—No, only the Type B.

542—*Q.—How do the various slack adjuster engines compare?* A.—The slack adjuster engine is the same general construction for all types, the variations being only in the body, to suit mounting requirements.

543—*Q.—What does the slack adjuster body contain?* A.—It contains a movable crosshead which serves as a fulcrum for the brake rigging cylinder lever. Movement is imparted to the crosshead through a screw, combined with a ratchet nut and pawl. The pawl is operated by a piston and spring.

544—*Q.—What controls the flow of air to and from the slack adjuster supply pipe which connects with the*

(*Continued on next left-hand page*)



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cylinder? A.—The brake cylinder piston and packing cup act as a valve to function in this respect.

545—*Q.—What determines the point at which air is admitted to the slack adjuster?* A.—The port in the brake cylinder to which the slack adjuster supply pipe is connected is so located that the packing cup uncovers it when the predetermined piston travel is exceeded.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Claim of Poor Workmanship On New Axle Not Sustained

On January 17, 1937, the Southern applied one pair of new wheels, mounted on a new axle, to T. C. X. 3491 at its Jacksonville, Fla., shop. On September 3, 1937, the Seaboard Air Line removed the same pair of wheels and substituted a second-hand pair because of "journal not properly burnished and tool marks." The Pennsylvania-Conley Tank Line contended that the Southern was responsible for the condition of the journals as reported by the Seaboard because of poor workmanship and that the charge for wheels and axle applied should be reduced to second-hand.

The Southern stated that this car made several trips after receiving the new pair of wheels and finally was delivered empty by the Seaboard to the Southern on September 2, 1937. It was returned to the Seaboard on the same day because the L-3 journal was cut. The Southern noted that the repair card of the Seaboard made no reference to the cut journal but had a notation of "the R-3 journal not properly burnished and tool marks". This road explained to the Pennsylvania-Conley that this was a case of delivering-line defect and that it should handle the matter with the Seaboard Air Line for cancellation of the bill. The Southern contended that it had no responsibility whatever in this case.

In a decision rendered April 14, 1939, the Arbitration Committee stated: "The evidence submitted indicates the axle required conditioning due to heating which, under Rule 84, is a delivery company responsibility. The contention of the Southern is sustained."—*Case No. 1770, Southern versus Pennsylvania-Conley Tank Line.*

Responsibility for Damages Due to Bad Track and Weather

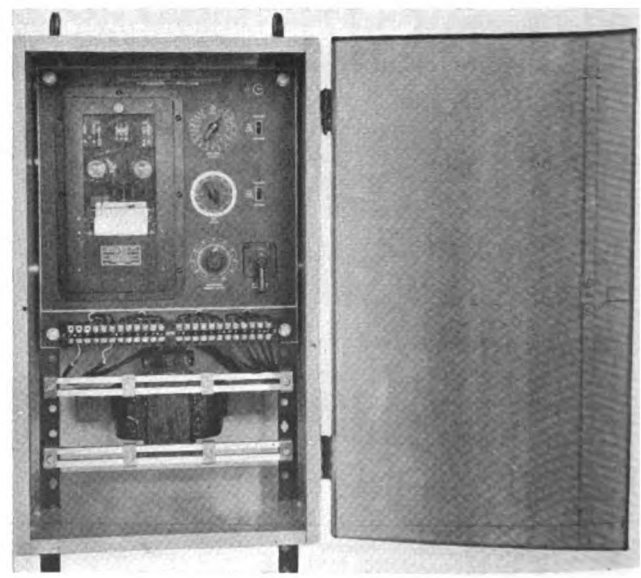
On February 16, 1938, a Missouri Pacific train stalled on a hill making it necessary to double the train over the hill. Texas & New Orleans car No. 39152 was the first car on the rear portion of the train and in making the coupling this car was damaged. The M. P. stated that there were no derailments of cars in this accident, no misinterpreted signals involved, nor any failure to give or observe signals and at the time of the accident it was cold, sleety and the rails were covered with ice. The T. & N. O. contended the engine collided with the rear portion of the train, making the damage a handling-line responsibility under the classification of train collision, specified in paragraph (c), Rule 32. The M. P. claimed there was no violation of Rule 32 as there were no cars derailed and that the locomotive in coupling on was moving on a down grade between six and eight miles per hour, and this speed could not be considered excessive in view of the weather and track conditions. It contended that since there was no element of negligence involved on the part of the M. P. to comply with every measure of safety in the handling of this car, and believed the responsibility for the damage should be charged to the car owner.

In a decision rendered April 14, 1939, the Arbitration Committee stated: "The circumstances under which this damage occurred as disclosed by the investigation of the M. P. clearly indicates the handling line responsibility under Item C, Section 10, Rule 32. The contention of the car owner is sustained."—*Case No. 1771, Missouri Pacific versus Texas & New Orleans.*

Weld Recorder Indicates Defective Welds

The increased use of welding and more rigid specifications have made sound, dependable welds a primary requirement. Spot welding is now being used extensively on structural members of railroad cars which are subjected to vibrational stresses of considerable magnitude. Because the numerous variables affecting the quality of spot welds are not under constant control, the General Electric Company, Schenectady, N. Y., has developed a weld recorder to record and indicate these variations. The weld recorder acts as a recording instrument, signalling device, and lockout control which measures the electrical input to the spot-welding machine for each spot weld.

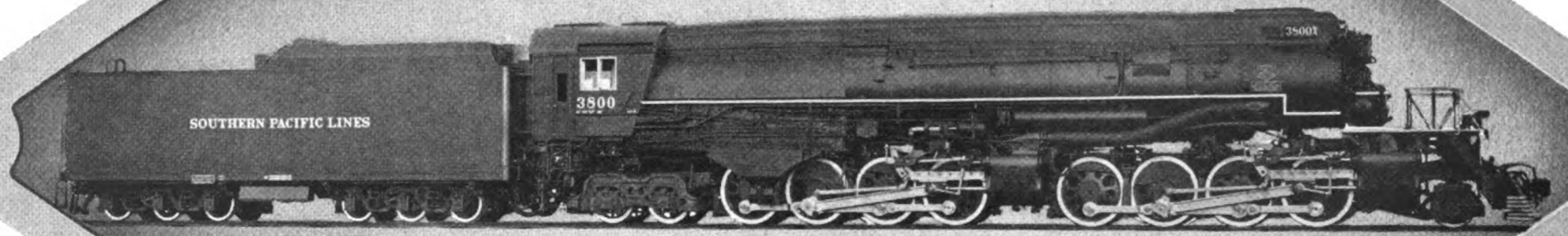
The weld recorder is so designed that when the electrical input to the welder varies sufficiently to cause a defective weld, a bell gives a continuous audible signal, and the weld-initiating circuit is automatically opened, preventing subsequent welding until a push button is pressed. In addition, the recorder chart indicates visually that the weld was not within the pre-set allowable limits for proper welding and shows whether the heat was above or below normal.



A General Electric Company's weld recorder

(Turn to next left-hand page)

TWELVE new 2-8-8-4 high-speed Mallets have recently been delivered by Lima to the Southern Pacific. These locomotives are outstanding examples of the type that is being ordered by the progressive railroads to meet the present-day demands of heavier loads moved at higher speeds.



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Mile-A-Minute Train Speeds

In 1928, except for one or two short runs in New Jersey, there was not a single train in the United States scheduled from start to stop at an average of more than 60 miles an hour. The Railroad Magazine has made a practice of compiling annual records of high train speeds and this year a summary of its article is being circulated by the A.A.R. According to this compilation, the passenger schedules of American railroads now show a daily mileage of 54,956 run at 60 miles per hour, or an increase of 16.7 per cent over the mile-a-minute mileage of a year ago.

Hard on Boilermakers

Water for locomotive use on the Western lines of the Illinois Central is highly mineralized and quite unsuitable for use in locomotive boilers. In 1915, and for several years prior thereto, there was a failure for every 5,000 locomotive-miles. Water treating methods were introduced and eventually improved to the point where since 1932 only softened water has been delivered to locomotives running west of Chicago. As a result, according to an article in the Railway Age, engine failures have been reduced to the point where, instead of one failure for every 5,000 locomotive miles, the ratio is now one engine failure to 10,000,000 locomotive-miles. Prior to 1929 it was necessary to rebuild fireboxes at intervals of 11 to 18 months. Contrasted with this, no firebox has been renewed on locomotives assigned to Western lines in more than 10 years, while on the system as a whole, only 10 fireboxes have been renewed during the last five years on the 1,523 locomotives in active service. Instead of the 75 boilermakers formerly employed at Waterloo, only 12 are now required, and one day and one night boilermaker are sufficient at the local enginehouses.

Wrecks in the Reich

It is difficult to know just what to believe about reports coming from countries engaged in war. There seems to be no question, however, about the fact that there have been ten serious railroad disasters on the German railways since the beginning of the European war four months ago. Well over 300 persons have been killed and as many injured. There is a good bit of guessing as to the underlying reasons for this. It has been suggested that undermaintenance has been steadily increasing over the long period during which the Nazis have been preparing for war. There is also a question as to the personnel and its morale. It hardly seems likely that the trained personnel would have been interfered with, since the strategic importance of the railways is so great in a conflict where large forces may have to be shifted quickly from one front to another. Confusion, however, may have been caused by the re-assignment of the forces to meet some of these conditions. Or the organization may have become exhausted or demoralized by the heavy demands which have been made upon it. The suggestion has also been made that the Fuehrer has concentrated too much attention on the marvelous system of motor highways, possibly to the detriment of the railways. If such serious difficulties are already being encountered, what will happen when the transportation system must be further speeded up, as the war progresses and more activity is shown on the western front?

Pipe Lines Lucrative

Harold Ickes, when he was administrator of the Code of Fair Competition for the petroleum industry, thought that the pipe line carriers were not charging enough for their services, or at least he urged the suspension of reduced rate tariffs filed by 37 carriers of crude oil by pipe line. The Interstate Commerce Commission assigned the job of checking up on these rates to its examiner, J. Paul Kelley, and his proposed report has just been made public. The oil companies maintain and control these pipe lines for their own use. Apparently these subsidiaries were making too much money, at least from the standpoint of federal income and other taxes. The proposed report reviewed returns to questionnaires which showed that "practically all of the respondents have in the period 1929-38 returned in dividends to their owners all of the moneys invested in the pipe lines." Since the pipe lines of these companies are not used by the public, except insofar as the oil companies for whose benefit the lines are operated constitute a part of the public, the examiner questions the advisability of suspending the reduced rate tariffs.

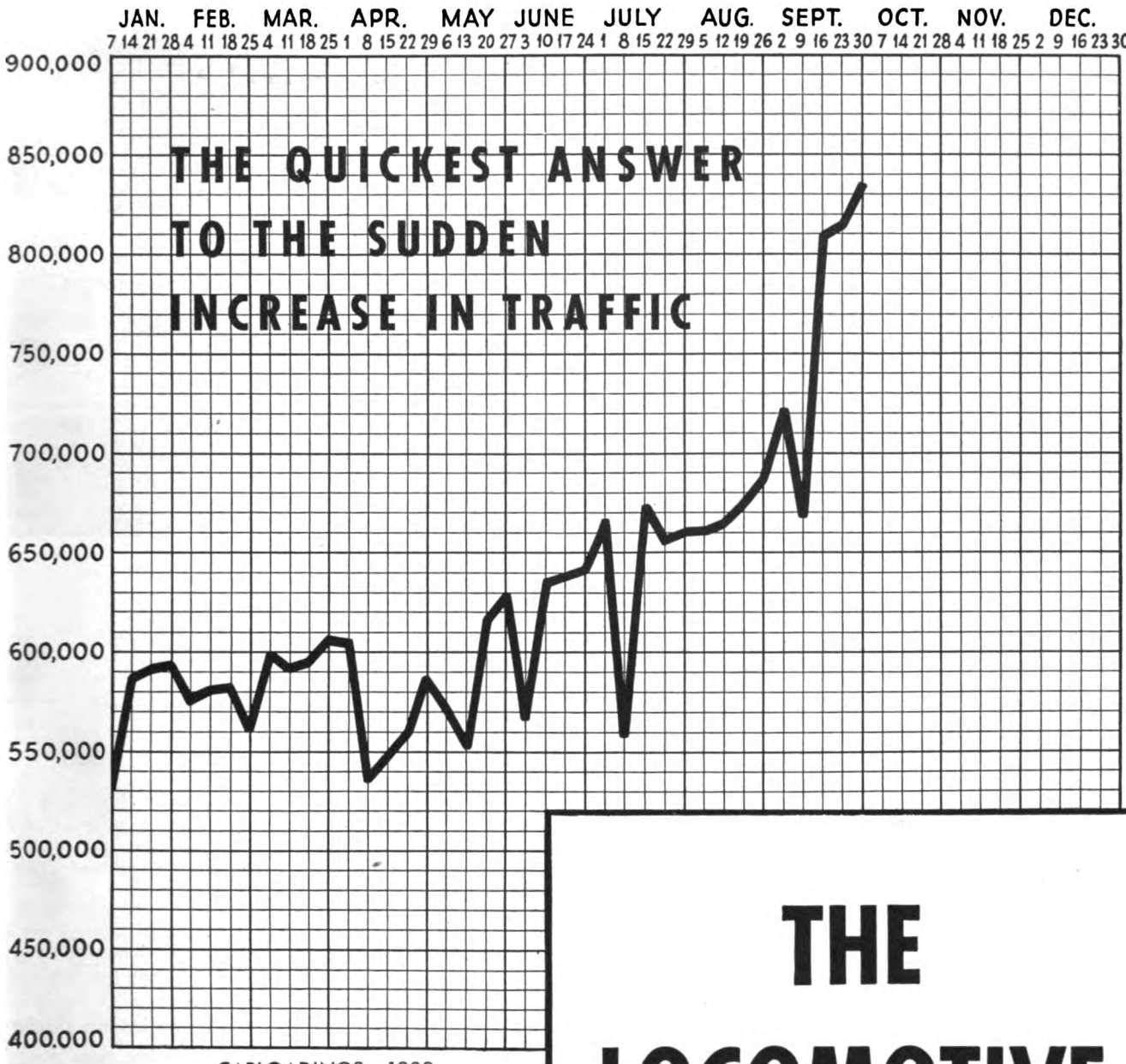
British Suburban Trains Allowed More White Light

The British public has not been any too well pleased with the blackout and the necessity of using blue lights on trains. It is impossible to read with such lights and this condition has proved irksome even in the short run suburban services. During the latter part of December several experiments were made on a fairly large scale with the limited use of white light. In general, the blue lights are kept on at all times. Between stations hooded white lights are also used, the curtains being carefully drawn down over the windows. The white lights are shut off when the trains approach stations and during the stop, in order that no rays of light may escape through the open doors as the passengers enter or leave the cars. The Southern Railway distributed leaflets to the passengers, explaining in great detail exactly what procedure should be followed. The statement closed with these words: "In this country the public have the reputation of playing the game and the Southern feels they will help in all ways possible to enable the government to give permanent permission to continue this form of lighting, and so assure comfort with safety for the passenger." It also pointed out that if the members of the traveling public play their part, not only will they be able to read their papers going home in the evening, but they will also assist in insuring that the trains will spend less time at stations and that they themselves will reach their homes earlier.

Canada's Railways on the Job

S. W. Fairweather, chief of research and development of the Canadian National Railways, pointed out recently in an address at Vancouver, B. C., that "It may well be that the decisive factor in favor of the Allies will be their superior lines of communication of sources of food, munitions and supplies." He also indicated that the railways of Canada form an important, if not a vital, link in the lines of communication of the Allies, and made some comparisons to show that they were much better equipped to meet the present situation than they were during the World War in 1914. At that time they were equipped with 80 and 90-lb. steel rails, whereas today the main line standard is from 100 to 130-lb. The largest road freight locomotive in 1914 had a tractive effort of 52,000 lb. This has increased until today it is over 90,000 lb. The average freight train of 1914 hauled 350 tons of freight, while the one of today hauls 550 tons. The average freight train speed has increased from 10 to 17 miles an hour. Today only 120 lb. of coal are burned to haul 1,000 tons a mile, as compared to 160 lb. in 1914. The average capacity of the freight car has increased from 33 tons to 42 tons. "The significance of those figures," said Mr. Fairweather, "is that for the same expenditures of labor and materials we manage to get 50 per cent more transportation today than we did in 1914."

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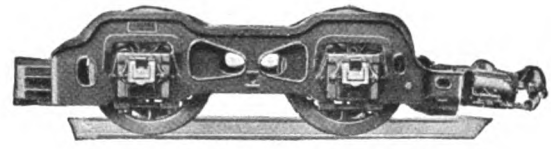


CARLOADINGS—1939

The deluge of increased freight tonnage presents a serious problem. In many cases existing equipment is already hauling capacity loads. The quickest and cheapest answer for this problem is to supplement your existing locomotives with Booster power.

The Booster materially increases the tractive starting effort and enables you to maintain better speed on grades. Use it to increase your locomotive capacity and prepare for heavier tonnage.

THE LOCOMOTIVE BOOSTER*



*Trademark Registered United States Patent Office

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK
CHICAGO
MONTREAL



The Diesel-powered "Henry M. Flagler" of the Florida East Coast operates between Jacksonville, Fla., and Miami

NEWS

Stock Locomotives To Be Built by Baldwin

AN initial investment of more than $2,000,000 is being made by The Baldwin Locomotive Works for facilities and stock to build 28 Diesel-electric switching locomotives of 1,000 and 660 hp. in line production so that certain types of railroad motive power can in future be chosen from stock. Two of the locomotives were recently demonstrated at its Eddystone, Pa., plant. The schedule calls for completion of the 28 engines for switching and transfer service, whether or not orders for them are received beforehand. The completion of smaller type locomotives for stock purposes is a new policy for Baldwin. The two engines displayed are powered by De La Vergne Diesels, manufactured by a Baldwin subsidiary; both are designed to provide good visibility, as a safety feature for yard service, and easy mechanical accessibility. The 1,000-hp. locomotive weighs 124 tons, while the weight of the 660-hp. locomotive is about 100 tons.

Fusion-Welded Tank Cars

THE General American Transportation Corporation has been authorized by the Interstate Commerce Commission to construct 50 additional fusion-welded tank cars for experimental service in the transportation of petroleum products.

The American Car and Foundry Co. has been authorized by the Interstate Commerce Commission to construct five additional fusion-welded tank cars for experimental service in the transportation of petroleum products, and to construct four tank cars with riveted aluminum alloy tanks for experimental service in the transportation of 95 per cent nitric acid.

Lawford H. Fry Now Chairman A. S. M. E. Railroad Division

FOLLOWING the annual meeting of the American Society of Mechanical Engineers held at the Bellevue-Stratford Hotel, Philadelphia, Pa., December 4-8, Lawford H. Fry, railway engineer, Edgewater Steel Company, succeeded to the chairmanship of the Railroad Division of the society. C. T. Ripley, chief engineer, Technical Board, Wrought Steel Wheel Industry, the retiring chairman, becomes a member of the Standing Committee on Professional Divisions of the society.

Occupations of Unemployment Insurance Beneficiaries

MAINTENANCE-of-equipment and maintenance-of-way employees constituted the majority of the claimants for whom one or more unemployment insurance payments had been certified by the Railroad Retirement Board by November 10.

As of that date there were 75,675 beneficiaries. The last occupation in which 71,923 of them were employed was readily identified from statements made on the claim form. Of this total 26,958, or 37.5 per cent, last worked in the maintenance-of-equipment department, and 17,517, or 24.4 per cent, in maintenance-of-way and structures. Train, engine and yard employees accounted for 17.8 per cent of the total and employees generally classified with the station forces constituted 13.9 per cent.

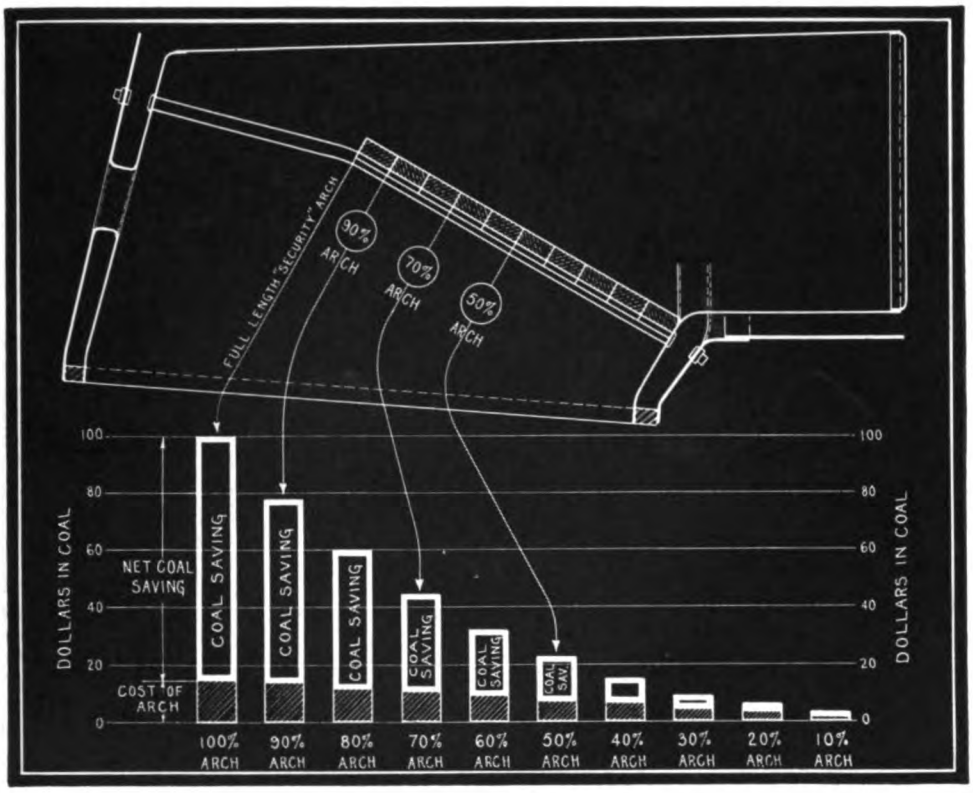
The figures apply to the country as a whole. The proportion of beneficiaries in different occupations, however, varied somewhat in the different regions.

Equipment Depreciation Orders

EQUIPMENT depreciation rates for six railroads, including the Southern Pacific and the Chicago Great Western, are prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15,100, Depreciation Charges of Steam Railroad Companies. The composite percentages, which are not prescribed rates range from 2.48 per cent for the Lorain & Southern to 3.13 per cent for the C. G. W., exclusive of equipment leased from the General American Car Corporation.

The Southern Pacific's composite percentage of 3.05 is derived from a variety of prescribed rates as follows: Steam locomotives, 2.9 per cent; other locomotives, 5.74 per cent; freight-train cars, 3.22 per cent; "City of San Francisco" type passenger equipment, 6.4 per cent; "Daylight" type passenger equipment, 3.84 per cent; all other passenger equipment, 2.58 per cent; floating equipment of Southern Pacific Steamship Lines, 2.83 per cent; all other S. P. floating equipment, 3.63 per cent; work equipment of S. P. Steamship Lines, 3.05 per cent; all other work equip-

(Continued on next left-hand page)



THE EFFECT OF ABBREVIATED ARCHES ON FUEL SAVING

LET THE ARCH HELP YOU SAVE

With the emphasis being placed on saving every railroad dollar, the locomotive Arch becomes increasingly important.

Regardless of the amount of traffic handled, the locomotive Arch saves enough fuel to pay for itself ten times over.

Be sure that every locomotive leaving the roundhouse has its Arch complete with not a single brick nor a single course missing.

In this way, you will get more work for each dollar of fuel expense. Skimping on Arch Brick results in a net loss to the railroad.

THERE'S MORE TO SECURITY ARCHES THAN JUST BRICK

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.

Locomotive Combustion Specialists

ment, 3.38 per cent; miscellaneous equipment of S. P. Steamship Lines, 10.53 per cent; all other miscellaneous equipment, 9.34 per cent.

The above-mentioned composite percentage of 3.13 for the C. G. W. is derived from prescribed rates as follows: Steam locomotives—owned, 3.03 per cent, leased from the Mason City & Fort Dodge, 2.35 per cent, leased from the St. Paul Bridge & Terminal, 3.2 per cent; other locomotives—owned, 4 per cent; freight-train cars—owned, 3.02 per cent; leased from M. C. & F. D., 1.93 per cent, leased from St. P. B. & T., 3.21 per cent, leased from General American Car Corporation, 3.6 per cent; passenger-train-cars—owned, 3.33 per cent, leased from M. C. & F. D., 2.27 per cent; work equipment—owned, 4.37 per cent; leased from M. C. & F. D., 2.28 per cent, leased from St. P. B. & T., 2.29 per cent; miscellaneous equipment—owned, 19.81 per cent.

A. S. M. E. Honors Railroad Engineers

At the annual dinner and "honors night" of the American Society of Mechanical Engineers held during the annual meeting of the society at the Hotel Bellevue-Stratford, Philadelphia, Pa., December 4 to 8, honorary membership in the society was conferred on Henry Hague Vaughn. Mr. Vaughn is widely known for his influence on the design of cars and locomotives and the organization of the shops on the Canadian Pacific while assistant to vice-president in charge of the mechanical department during the nine years prior to 1915. Since leaving the railroad in 1915, Mr. Vaughn has been engaged in industry and as a consulting engineer in Canada.

Dr. Rupen Eksergian of the Edward G. Budd Manufacturing Company was the recipient of the Worcester Reed Warner Medal awarded for his contributions to permanent engineering literature. Dr. Eksergian has been a prolific writer on various phases of locomotive and car design and on applied mechanics subjects.

Equipment Purchasing and Modernization Programs

Chicago Great Western.—The federal district court at Chicago on December 6 authorized the Chicago Great Western to execute a lease with the Pullman Standard Car Manufacturing Company involving $200,000 for 100 flat cars, under the terms of which lease payments would apply toward eventual purchase of the cars. The placing of the order for these cars was announced in the November issue of the *Railway Mechanical Engineer.*

Chicago, Rock Island & Pacific.—The Rock Island has asked the Interstate Commerce Commission to approve a plan whereby it would issue and sell to the Reconstruction Finance Corporation $2,680,000 of 2¾ per cent equipment trust certificates, maturing in 20 equal semi-annual installments beginning August 1, 1940. The proceeds would be used in part payment for the purchase of 1,000 50-ton box cars and 10 Diesel-electric switching locomotives, costing a total of $2,993,420. The placing of the orders for this equipment was announced in the November and December issues, respectively.

The Rock Island has also undertaken a locomotive modernization program calling for the expenditure of about $600,000. Roller bearings are being applied to 55 locomotives, of which 40 are in freight service and 15 in passenger service. In addition to the installation of roller bearings, some of the passenger locomotives are being rebuilt.

Colorado & Southern-Fort Worth & Denver City.—These companies have asked the Interstate Commerce Commission to approve a plan whereby they would borrow from the Reconstruction Finance Corporation $1,300,000 to finance the purchase of two new Diesel-electric streamline Zephyr-type trains to be operated in daily overnight service over the Colorado & Southern and the Fort Worth & Denver City between Denver, Colo., and Dallas, Tex., on a schedule six hours faster than is now in effect. The two companies estimate that the installation of the new trains would increase passenger earnings and result in savings totaling $335,844 a year. They would issue and sell to the Reconstruction Finance Corporation three per cent equipment trust certificates to mature serially over a period of 10 years. In separate applications the C. & S. asked for a loan of $680,500, while the Fort Worth & Denver City requested $619,500. The application pointed out that the Diesel-electric locomotives can be purchased from the Electro-Motive Corporation for $376,000 each, while each train of four cars can be obtained from the E. G. Budd Manufacturing Company at a price of around $304,500.

Illinois Central.—Interstate Commerce Commission Finance Director O. E. Sweet has informed this company that Division 4 cannot approve the new $5,000,000 Reconstruction Finance Corporation loan for the equipment repairs mentioned in the November issue of the *Railway Mechanical Engineer*, on the ground that the collateral offered is insufficient to secure the advance. The Illinois Central refused to withdraw its application.

New York Central.—The New York Central has been authorized by Division 4 of the Interstate Commerce Commission to assume liability for $9,000,000 of 2½ per cent equipment trust certificates, maturing in 10 equal annual installments of $900,000 on December 1 in each of the years from 1940 to 1949, inclusive. At the same time Division 4 authorized sale of the certificates to the Reconstruction Finance Corporation at par and accrued interest with the stipulation that the company agree with the R. F. C. that it will spend within one year from October 1, 1939, not less than $3,600,000 in repairing and reconditioning its own equipment. This is the first time that an R. F. C. loan has contained the latter condition.

St. Louis-Southwestern.—A budget providing for the expenditure of $2,082,754 for additions and betterments on the St. Louis Southwestern in 1940, was approved by the federal district court on December 15. The amount includes $562,022 for freight cars to be built in company shops and $243,088 for rails ordered last October.

Tennessee Central.—The Tennessee Central has asked the Interstate Commerce Commission to approve a plan whereby it would issue and sell to the Reconstruction Finance Corporation $185,000 of 2¾ per cent equipment trust certificates, maturing in 20 semi-annual installments of $10,000 on July 1, 1940, and the same amount on January 1, and July 1, thereafter, to and including July 1, 1942, and in the amount of $9,000 on January 1, and July 1, in each of the years thereafter to and including

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Orders and Inquiries for New Equipment Placed Since the Closing of the December Issue

Locomotive Orders

Road	No. of Locos.	Type of Loco.	Builder
Canadian Pacific	5	4-6-4	Montreal Loco. Wks.
C. B. & Q.	10	4-8-4	Company shops
D. & H.	20	4-6-6-4	American Locomotive Co.
Panama Canal	5	2-6-0	American Locomotive Co.
Wheeling & Lake Erie	4	0-6-0	Company shops

Freight-Car Orders

Road	No. of Cars	Type of Car	Builder
Lake Terminal	100	70-ton gondola	American Car & Fdy. Co.
United Fruit Co.	77	25-ton flat	Magor Car Corp.

Freight-Car Inquiries

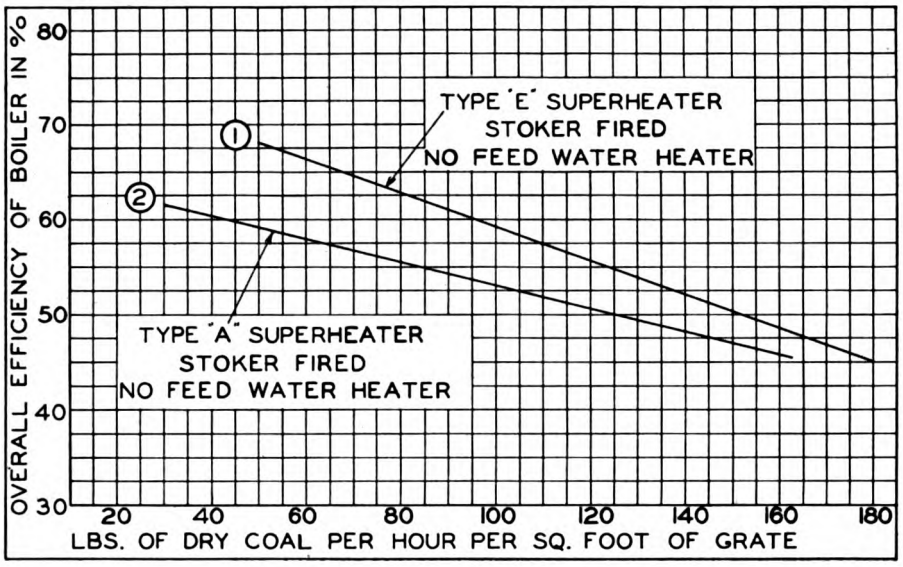
Norfolk & Western	100	50-ton box	.....

Passenger-Car Orders

Road	No. of Cars	Type of Car	Builder
Pullman Company	13	Roomette-bedroom	Pullman-Std. Car Mfg. Co.
	6	Roomette	.....
	11	Bedroom-compartment-drawing room	.....
	8	Bedroom	.....
	12*	Bedroom-buffet-lounge	.....
	33	Roomette-bedroom	.....
	4	Duplex single-bedroom	.....
	13†	Bedroom-buffet-lounge	.....
Richmond, Fredericksburg & Potomac	6	Bagg.-exp.	American Car & Fdy. Co.

* For use on the New York Central.
† For use on the Pennsylvania.

THE SUPERHEATER AS A FACTOR IN LOCOMOTIVE DESIGN



Heating Surface and Boiler Efficiency

At high rates of operation, the greatest part of the heat from the fuel is absorbed by the flues. Maximum boiler capacity, therefore, requires a boiler with the largest possible heating surface within clearance limits, proportioned for highest efficiency of heat absorption with minimum draft loss.

With the Type "E" superheater the diameter of flue and superheater pipe are so chosen as to give the highest practical flue efficiency for a given length of flue.

The curves show comparative boiler efficiencies obtained from actual tests. The boilers are identical in every respect with the exception of the superheater, one being equipped with a Type "A" superheater and the other with a Type "E" superheater. These curves are typical of the results being obtained on a great many tests.

ELESCO

A-1384

THE SUPERHEATER COMPANY

Representative of AMERICAN THROTTLE COMPANY, INC.

60 East 42nd Street, NEW YORK 122 S. Michigan Ave., CHICAGO

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Superheaters « Exhaust Steam Injectors « Feedwater Heaters « American Throttles « Pyrometers « Steam Dryers

January 1, 1950. The proceeds would be used to purchase the 65 all-steel 50-ton hopper cars and one Diesel-electric switching locomotive, the placing of orders for which were announced in the November and December issues respectively.

Texas & Pacific—The Texas & Pacific has been authorized by Division 4 of the Interstate Commerce Commission to assume liability for $1,335,000 of three per cent equipment trust certificates, maturing in 15 equal annual installments of $89,000 on January 15 in each of the years from 1941 to 1955, inclusive. At the same time Division 4 approved the purchase by the Reconstruction Finance Corporation of the entire issue at a price not in excess of par and accrued interest.

Commissioner Porter dissented, saying that "The cash payment is to be less than 0.7 per cent of the applicant's outlay for the equipment. Several times I have indicated my unwillingness to approve borrowing on new equipment of more than 90 per cent of the net cost thereof. Especially would such a policy incur no hardship here, for the applicant anticipates a cash balance by the end of the year of over $2,300,000 and is well able to pay at least 10 per cent if not 20 per cent in cash at the time of the purchase."

Wabash—Division 4 of the Interstate Commerce Commission has approved a loan to the Wabash by the Reconstruction Finance Corporation in the amount of $9,300,000, of which $6,500,000 is to be applied to the retirement of a like amount of equipment notes issued by the company to the R. F. C., and $2,800,000 to be applied to the cost of repairing and rehabilitating 1,694 automobile box cars. The loan will be evidenced by 2½ per cent equipment trust certificates, maturing in installments of at least $620,000 semiannually on July 1 and January 1 of each year until the full amount has been repaid, the first installment to be due and payable on July 1, 1940, and the last installment to be due and payable on July 1, 1947, with the further provision that the company may make additional payments of not less than $25,000 on account of unmatured installments of principal.

Charles F. Carter Dies at 76

CHARLES Frederick Carter, believed to be one of the country's most prolific writers of railroad stories and articles, died on December 10 at his home in New York at the age of 76.

Mr. Carter's interest in railroading began in 1881 when he obtained his first railroad job as an engine wiper on the Chicago, St. Paul, Minneapolis & Omaha. In 1889, he entered journalism as a reporter and later filled more advanced editorial positions on various papers in Denver, Colo., New York and Brooklyn. In 1906, Mr. Carter joined the staff of "Railroadman's Magazine." From 1923 to 1932 he was special representative in the New York Central's department of public relations.

He was author of "When Railroads Were New," published originally in 1909, and in a revised centenary edition in 1926; "Big Railroading," published in 1919, and numerous magazine and encyclopedia articles on industrial and economic subjects.

Outlook "More Encouraging" Says Pelley

WHILE he found the outlook for the railroads "more encouraging" as the year 1939 drew to a close, J. J. Pelley, president of the Association of American Railroads, nevertheless asserted in his year-end statement that the improvement in traffic and earnings "does not obviate the need for a national transportation policy placing all agencies of transportation on a equal footing under the law." He went on to express the hope that the differences between the Senate and House versions of S. 2009, the omnibus transportation bill, "will be ironed out early in the coming session of Congress and the resulting bill speedily enacted into law."

From preliminary reports Mr. Pelley estimated that the 1939 net railway operating income will be $600,000,000, a return of 2⅛ per cent, while the net income after fixed charges will be $95,000,000, as compared respectively with a net railway operating income of $372,874,000 or 1.43 per cent and a net deficit after fixed charges of $123,471,074 in 1938.

Mr. Pelley said that the railroads will enter 1940 with a freight traffic level approximately 10 per cent higher than a year ago and about 18 per cent above two years ago. Despite the record-breaking climb in traffic during the fall, he said that the railroads have met the transportation situation successfully with virtually no car shortage except for a few isolated cases where slight delays occurred in furnishing certain special types of cars. The speeding up of equipment maintenance and the increase in freight movement, he said, had increased employment on the railroads until in October there were 1,005,164 employees, more than in any month since November, 1937, and nearly 80,000 more than in October, 1938. Of the total number, 511,358 were engaged in maintenance work, an increase of 53,612 over October, 1938.

In the matter of expenditures, Mr. Pelley cited the fact that the purchases of fuel, supplies and materials used in current operation in 1939 amounted to $750,000,000 for the Class I railroads, compared with $583,282,000 in 1938 and $966,383,000 in 1937. The capital expenditures for equipment, roadway and structures and other improvements in property for 1939, he said, were estimated at $375,000,000, compared with $226,937,000 a year ago. This he contrasted with $794,000,000 average annual capital expenditures from 1927 to 1930.

Supply Trade Notes

THOMAS E. SCULLY has been appointed representative of the Chicago Railway Equipment Company, Chicago.

◆

R. J. VAN METER, assistant to the vice-president of the Superheater Company, Chicago, has been promoted to manager of western sales and service.

◆

FRANK T. KALAS, general sales manager of The Electric Storage Battery Company, Philadelphia, Pa., has been elected third vice-president.

◆

JOHN A. DILLON, vice-president in charge of eastern sales of the Pittsburgh Screw and Bolt Corporation, New York, resigned on January 1. He was associated with this company for more than 20 years. Mr. Dillon started in the steel business in connection with the National Tube Company at Pittsburgh, Pa., and was later transferred to their New York office where he was employed for 13 years before entering the service of the bolt and nut trade.

ARTHUR E. LEGARE, sales engineer of the General Steel Castings Corporation at Granite City, Ill., has been transferred to Chicago, from which he will handle the same territory as heretofore.

◆

DR. WILLIAM A. MUDGE has joined the technical service division of the New York office of The International Nickel Company, Inc. For the past 17 years, Dr. Mudge has been superintendent of research, superintendent of the refinery and works metallurgist at the company's Huntington, W. Va., rolling mill and for two years previous was at the company's Bayonne, N. J., refinery, where he joined International Nickel in 1920.

◆

JAMES ISAACS has been appointed assistant to president of The Pilliod Company, with headquarters at 30 Church street, New York City. Mr. Isaacs, who has been associated with the railway supply industry since 1920, will continue to represent manufacturers as in the past.

THE MILLER-LEWIS RAILROAD EQUIPMENT CORPORATION, 80 Reade street, New York, has been appointed eastern representative of the Standard Car Truck Company, Chicago, and its division, Standard Car Sales, Inc., a recently-formed corporation.

◆

H. B. GAY, third vice-president and general sales manager, also a member of the board of directors of The Electric Storage Battery Company, retired from active service on December 1 after thirty-eight years in the employ of the company.

◆

MAYNARD D. CHURCH has been elected a vice-president of the Worthington Pump & Machinery Corp., Harrison, N. J. Mr. Church is also president of the Moore Steam Turbine Corporation, Wellsville, N. Y., a Worthington subsidiary, and will continue in charge of the Moore operations. R. W. Towne, secretary and assistant treasurer since 1936 of the Moore organi-

zation, has been elected assistant secretary of the Worthington Pump & Machinery Corp.

◆

JAMES E. DAVENPORT has been appointed assistant to vice-president-engineering, American Locomotive Company, with office at New York and with such duties as may be assigned to him. Mr. Davenport was born at Charlestown, W. Va., on October 8, 1887. He was graduated from the Georgia School of Technology with a B. S. in M. E., in 1908, and a B. S. in E. E. in 1909. Mr. Davenport entered railway



James E. Davenport

service in 1909 as a special apprentice at the West Albany, N. Y., shops of the New York Central and his entire career has been with that road. From 1912 to 1914, he was enginehouse foreman at North White Plains, N. Y., then to 1917, dynamometer car engineer. During 1917 and 1918 he was trainmaster on the Harlem division and then to 1920, trainmaster on the Mohawk division. From 1920 to 1923 he was engineer, dynamometer tests, and then to 1926, superintendent, fuel and locomotive performance. He served in 1926 and 1927 as superintendent of the Adirondack division, then for the next three years as superintendent of the River division. In 1930 he was appointed assistant to assistant general manager, and in 1931 became assistant to executive vice-president. From 1936 until his resignation to become associated with the American Locomotive Company, Mr. Davenport had been assistant chief engineer of motive power and rolling stock. During 1927-1928 he was president of the International Railway Fuel Association.

◆

THE VANADIUM CORPORATION OF AMERICA has moved its Pittsburgh, Pa., district sales office from its Bridgeville, Pa., plant to the Henry W. Oliver building, Pittsburgh. G. F. Fritschi is the Pittsburgh district manager of sales.

◆

HERBERT J. WATT has been appointed manager of sales for the central area of the Carnegie-Illinois Steel Corporation. Mr. Watt will co-ordinate sales activities of Carnegie-Illinois offices at Pittsburgh, Pa., Cleveland, Ohio, Cincinnati, and Detroit, Mich. His headquarters will be at the general offices in the Carnegie building, Pittsburgh. Mr. Watt entered the steel industry in the Philadelphia office of Carnegie Steel Company in 1912 and in 1917 was transferred to the Washington office of United States Steel Corporation Subsidiaries. He was formerly assistant general manager of sales for the Jones & Laughlin Steel Corporation.

◆

J. B. PEDDLE, Paul Brown building, St. Louis, Mo., has been appointed St. Louis district sales representative for the McConway & Torley Corporation, Pittsburgh, Pa.

◆

HARRY GLAENZER, vice-president in charge of engineering of The Baldwin Locomotive Works has retired because of ill health. Mr. Glaenzer was educated in the technical schools of Baltimore, Md., and in the University of Pennsylvania. His work in the engineering department of Baldwin began in March, 1899, and covered all phases of locomotive design. During the years 1918-1919, while the railroads of the country were being operated by the United States Railroad Administra-



H. Glaenzer

tion, Mr. Glaenzer was actively associated with the committees that prepared designs for a series of standard locomotives. He was appointed assistant chief engineer of The Baldwin Locomotive Works in 1919, chief engineer in 1921, and vice-president in charge of engineering on July 1, 1922. In 1924 he made a trip to Japan, where he studied the equipment and operation of the Japanese Railways. On April 8, 1939, he assumed new and enlarged responsibilities in connection with the engineering activities of Baldwin, devoting all his time to research and investigation. Mr. Glaenzer has patented various devices applicable to locomotives and was chairman of the builders' committee which collaborated with the Pennsylvania in the design of the Class S-1 locomotive exhibited at the New York World's Fair in 1939. He also served on the A.A.R. Committee for the Further Development of the Reciprocating Steam Locomotive.

◆

LOUIS H. BRENDEL, assistant sales manager of the Hancock Valve Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., has been promoted to assist C. H. Butterfield, general sales manager of the company.

STANDARD CAR SALES, INC., Chicago, has been organized to act as manufacturers' representatives for car devices. At the present time, the company is selling the Champion handbrake manufactured by the Champion Handbrake Corporation, Chicago, and the Walton air filter manufactured by the Research Products Corporation, Madison, Wis. The officers of the new company are F. L. Barber, chairman of the board; R. E. Frame, president; F. D. Barber, vice-president; John W. Miller, vice-president; V. Fraser, secretary, and John E. Edgerton, treasurer.

◆

THE ARDCO MANUFACTURING COMPANY has moved its office from 1 Newark street, Hoboken, N. J., to 137-143 Franklin street, Jersey City, N. J. At the new address they will combine their office with their manufacturing facilities which include locomotive drifting valves, cylinder cocks and rail lubricators.

◆

WILLIAM M. SHEEHAN, manager of Eastern district sales for the General Steel Castings Corporation, Eddystone, Pa., has been appointed assistant vice-president-sales, and James Macdonald, sales representative, has been promoted to assistant to the vice-president-sales. Mr. Sheehan was born in Virginia and was educated in St. Andrew's school, Roanoke, Va., and St. Louis university. His early railroad experience was secured on the Norfolk & Western and the Erie. Later he served for a time in the engineering departments of the General Electric Company, the American Locomotive Company, the New York Air Brake Company, and the Keith Car & Mfg. Co. Since 1913 he has been



W. M. Sheehan

associated with the Commonwealth Steel Company and its successor, the General Steel Castings Corporation, as assistant mechanical engineer, sales engineer, and, since July 1, 1931, as manager, Eastern district sales. Mr. Macdonald was associated with the Baldwin Locomotive Works in various capacities from 1931 until January, 1939, when he joined the sales force of the General Steel Castings Corporation.

◆

WALTER CHADWICK, executive vice-president of the Davenport Besler Corporation, Davenport, Iowa, has been elected president, to succeed Charles Pasche, deceased.

(*Continued on second left-hand page*)

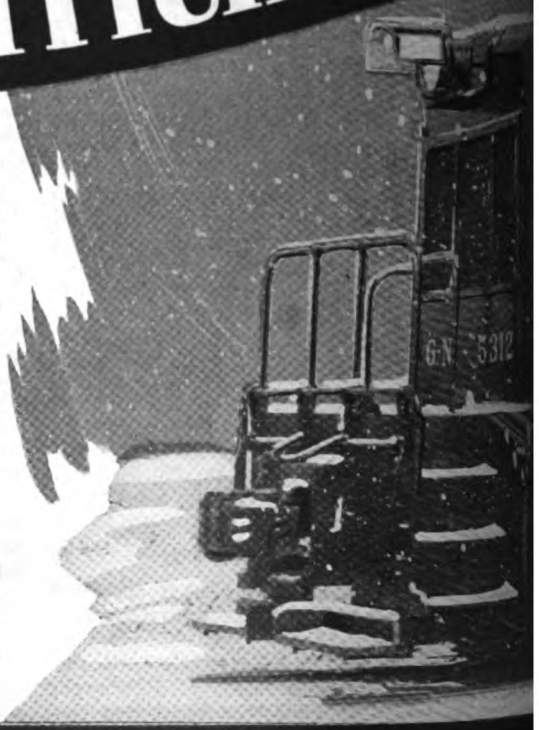


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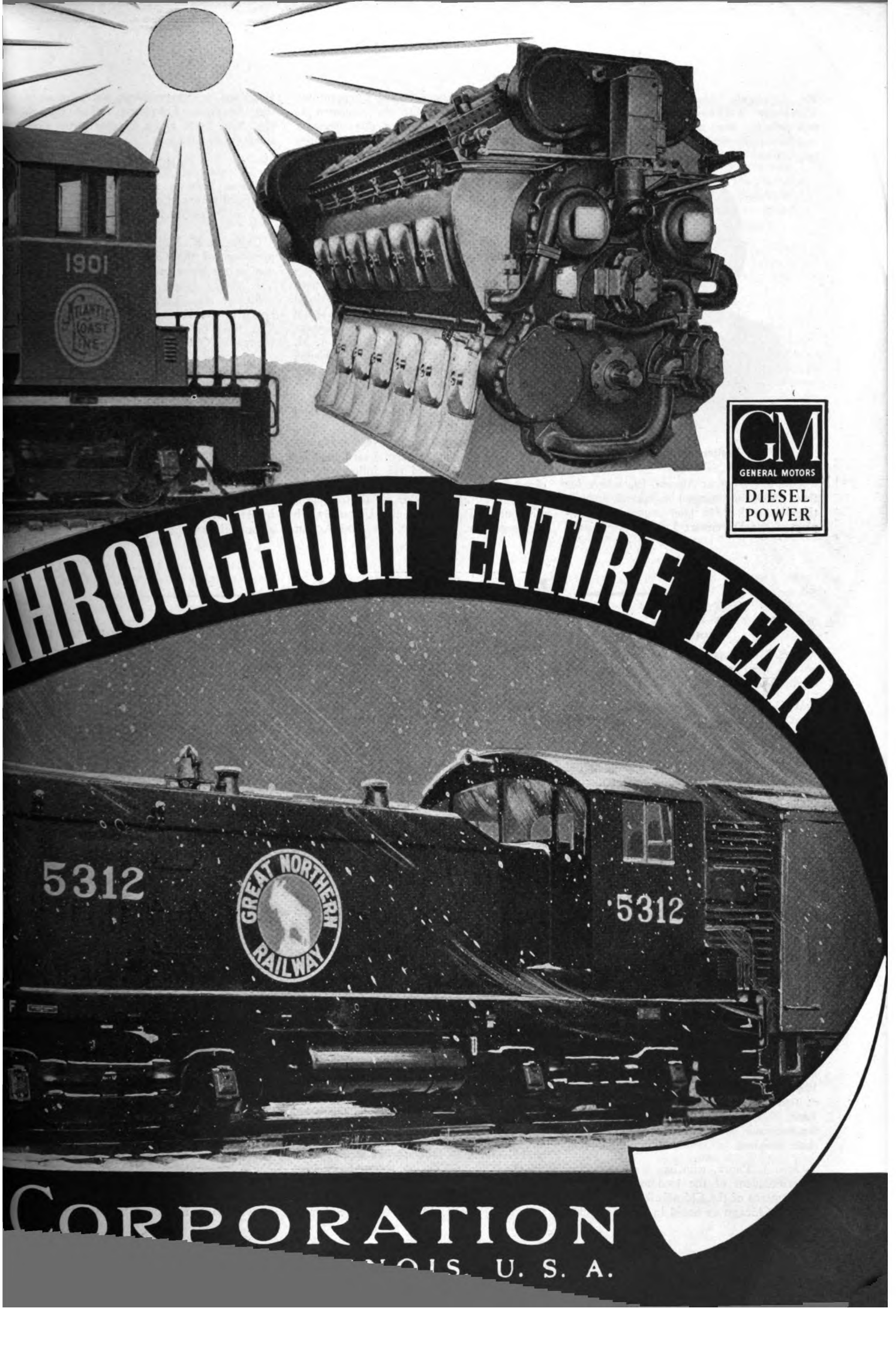
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Mr. Chadwick was graduated from the University of Illinois in 1905, and since that time has been associated with railroad and locomotive building activity. He began his railroad career with the Chicago, Burlington & Quincy at Aurora, Ill., where for three years he engaged in special apprenticeship work. He later entered the employ of the Davenport Locomotive Works (now the Davenport Besler Corporation) and after 20 years with the company resigned from the position of sales manager to become vice-president of the Clapp-Riley and Hall Equipment Company, Chicago. In 1937, Mr. Chadwick returned to the Davenport Besler Corporation as executive vice-president.



Walter Chadwick

◆

I. N. KIMSEY, salesman in the Akron sales division of The B. F. Goodrich Company, Akron, Ohio, has been appointed manager of that division and R. A. Charlton on the sales staff at Akron, has been appointed assistant manager of the Akron sales division. J. S. Gulledge, in the Akron sales division, has been appointed manager of the St. Louis, Mo., district, and A. M. Fiala, salesman in the Akron sales division, has been appointed product sales manager of the Air-Cell division, devoted to sales of the company's new latex cushioning material.

◆

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., at a recent board meeting in New York, elected the following new directors: George A. Blackmore, president of the Westinghouse Air Brake Company, Pittsburgh, Pa., and of the Union Switch & Signal Co., Swissvale, Pa., and Arthur W. Page, a vice-president and director of the American Telephone and Telegraph Co., New York, and a director of the Continental Oil Company.

Obituary

JAMES GLOVER, sales representative of the Scullin Steel Company, St. Louis, Mo., died on December 11, at St. Louis.

◆

CHARLES K. KNICKERBOCKER, first vice-president of the Griffin Wheel Company, died at his home in Chicago on January 7.

◆

HENRY G. DALTON, chairman of the board of the Youngstown Sheet and Tube Co., died on Dec. 27 in a hospital at Cleveland, Ohio, at the age of 77 years.

◆

EDWIN W. ALLEN, vice-president of the General Electric Company, died on January 1, in the Johns Hopkins Hospital, Baltimore, Md. Mr. Allen was 60 years of age at the time of his death.

◆

WALTER C. LEWIS, employed by the National Malleable & Steel Castings Company since 1906, and their sales agent in New York City for the last 19 years, died in Mt. Vernon, N. Y., on December 3, after a long illness.

Personal Mention

General

C. S. MAYS has been appointed fuel agent on the Southern at Knoxville, Tenn., succeeding E. G. Goodwin.

W. V. HINERMAN, master mechanic of the Chesapeake & Ohio, with headquarters at Hinton, W. Va., has been appointed assistant to superintendent motive power. Mr. Hinerman's headquarters will be at Richmond, Va.

C. E. POND, assistant master mechanic of the Radford and Shenandoah divisions of the Norfolk & Western at Roanoke, Va., at Roanoke, Va., has been appointed assistant to the superintendent of motive power, with headquarters at Roanoke. Mr. Pond was graduated in mechanical engineering from the Virginia Polytechnic Institute and entered the service of the Norfolk & Western as a special apprentice in the Roanoke shops in June, 1923. Two months later he was transferred to Portsmouth, Ohio, as shop inspector and served there for two years until August, 1925, when he was promoted to assistant engineer of tests, at Roanoke. In 1928 he was appointed assistant foreman of the frog shop and in January, 1937, assistant foreman of the blacksmith shop, becoming foreman of the latter shop the same year. In 1938 he was promoted to general foreman of foundries, which position he held until June, 1939, when he became assistant master mechanic of the Radford and Shenandoah divisions.

OTTO J. PROTZ, who has been appointed superintendent of the locomotive and car departments of the Chicago & North Western at Chicago as noted in the November issue of the *Railway Mechanical Engineer*, was born on February 23, 1886, at Winona, Minn. He attended public and high schools in Winona until 1902, and on April 9, 1903, entered the employ of the C. & N. W. as a pipe-fitter helper. He then served for four years as a machinist apprentice and, until February 1, 1914, as a machinist. He then became enginehouse foreman at Wyeville, Wis., and on September 1, 1914, was transferred to Huron, S. D., as enginehouse foreman at that point. On October 18, 1920, he was promoted to the position of general foreman, serving until September 18, 1922, at Belle Plains, Iowa; until January 1, 1923, at Huron; and until February 1, 1927, at Chicago shops, locomotive department. He was appointed master mechanic at Winona, Minn., on April 1, 1928, and at Escanaba, Mich., on November 1, 1929. On September 1, 1931, Mr. Protz went to Clinton, Iowa, as assistant master mechanic, and on October 1, 1939, was appointed superintendent of the locomotive and car departments, Chicago shops.



Karmen-Winger Studios

O. J. Protz

H. A. STEWART, general mechanical inspector of the Fruit Growers Express Company at Alexandria, Va., retired on November 15 after 43 years' service.

E. L. JOHNSON, engineer of tests of the New York Central system, with headquarters at New York, has been appointed assistant chief engineer motive power and rolling stock, with headquarters at New York, succeeding James E. Davenport. Mr. Johnson was born at Wilkinsburg, Pa. He was educated at the University of Pittsburgh and entered the service of the



E. L. Johnson

New York Central as a special apprentice in July, 1916, at the Beech Grove, Ind., shops. He was appointed assistant engineer of materials and equipment tests early in 1925, having previously served as engineer of service tests. He became engineer of tests early in 1937.

W. F. COLLINS, assistant engineer of tests of the New York Central, has been appointed engineer of tests, with headquarters at New York, succeeding E. L. Johnson.

Master Mechanics and Road Foremen

P. P. FAULDS has been appointed assistant road foreman of engines of the Philadelphia division of the Pennsylvania.

J. ALLEN CLARK, road foreman of engines of the Northern Pacific at Missoula, Mont., has been promoted to master mechanic at Spokane, Wash., replacing L. J. Gallagher.

PAUL THOMAS, enginehouse foreman of the Pennsylvania at Williamsport, Pa., has been appointed assistant master mechanic, Panhandle division.

M. M. QUINN has been appointed assistant road foreman of engines of the Maryland division of the Pennsylvania, with headquarters at Wilmington, Del.

F. H. WINGET, assistant master mechanic on the Cleveland, Cincinnati, Chicago & St. Louis at Bellefontaine, Ohio, has been promoted to master mechanic, with the same headquarters, succeeding J. J. Karibo, who retired on October 1.

C. M. PETTRY, general foreman of the Shaffers Crossing shops of the Norfolk & Western, has been appointed assistant master mechanic of the Radford and Shenandoah divisions, with headquarters at Roanoke, Va., succeeding C. E. Pond.

W. H. POWELL has been appointed road foreman of engines of the Baltimore & Ohio, with headquarters at Chillicothe, Ohio.

HARVEY SMIRES, assistant road foreman of engines of the Maryland division of the Pennsylvania, has been appointed assistant road foreman of engines, Middle division, with headquarters at Altoona, Pa.

M. G. STEWART, assistant road foreman of engines of the Philadelphia division of the Pennsylvania, has been appointed assistant road foreman of engines, Williamsport division.

Car Department

CUTHBERT STEEVES has been appointed assistant foreman, freight-car shop, of the Canadian National, with headquarters at Moncton, N. B.

H. A. BOURDEAU, general foreman in charge of the locomotive shop and enginehouse of the Canadian National at Riviere du Loup, Que., has had his jurisdiction extended to include car department matters at that point.

BENJAMIN BISHOP, assistant foreman, freight-car shop, of the Canadian National at Moncton, N. B., has been appointed foreman, freight-car shop, with headquarters at Moncton.

Shop and Enginehouse

DALE J. MOSES has been appointed locomotive foreman of the New York, Chicago & St. Louis, with headquarters at Conneaut, Ohio.

ROBERT MAHONEY has been appointed foreman, mechanical department, of the New York, Chicago & St. Louis, with headquarters at Conneaut, Ohio.

MARTIN H. NELSON, general locomotive foreman on the Northern Pacific, with headquarters at Brainerd, Minn., has been appointed acting shop superintendent at that point, succeeding H. E. Bergstrom, who has resigned.

Purchasing and Stores

THOMAS E. SAVAGE, assistant purchasing agent of the Erie at Cleveland, Ohio, has been appointed purchasing agent at Cleveland. Mr. Savage was born in 1887, and entered railway service 36 years ago as an



Thomas E. Savage

office boy in the purchasing department of the Erie. He advanced through various positions in that department and in the fall of 1923 was promoted to assistant to the manager of purchases, with headquarters at New York. On July 16, 1930, he became assistant purchasing agent, with the same headquarters, later being transferred to Cleveland, when the Erie moved its general offices to that point.

H. O. WOLFE, division storekeeper of the Alton, at Bloomington, Ill., has been appointed assistant to the purchasing agent, with headquarters at Chicago, a newly-created position.

L. V. FOLEY, assistant division storekeeper of the Alton, has been promoted to the position of storekeeper, with headquarters as before at Bloomington, Ill., succeeding to the duties of H. O. Wolfe.

Obituary

J. H. SCHROEDER, general foreman car department, Delaware, Lackawanna & Western, with headquarters at Kingsland, N. J., died on November 11 at the Dover (N. J.) General hospital, at the age of 68.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

CRANES.—Whiting Corporation, Harvey, Ill. Loose-section catalog descriptive of Whiting cranes for foundries, machine shops, railroad shops, etc.

◆

"AN ALCO DIESEL FOR UNIVERSAL APPLICATION."— American Locomotive Company, 30 Church street, New York. Booklet illustrating use of Alco engines in railroad and other fields. Ratings between 400 and 1,200 hp., turbocharged (Buchi system) and non-turbocharged, gas or Diesel.

◆

CARBOLOY. — Carboloy Company, Inc., 11157 East 8 Mile Road, Detroit, Mich. Bulletin GT-120. Discusses fundamentals of cutting steel with carbide tools, with charts giving specific carbide grades to use, recommended starting speeds, tool rakes and clearances, etc.

◆

HOISTS.—Coffing Hoist Company, Danville, Ill. Catalog No. G-1. Illustrates and describes Coffing products—hoists, maintenance tools, trolleys, etc.—for use in various fields, including railroad applications.

◆

ARC-WELDING ELECTRODES. — General Electric, Schenectady, N. Y. 40-page illustrated booklet outlining various considerations involved in making proper selection of arc-welding electrodes with a description of characteristics and quality of each type recommended.

◆

UNIVERSAL TURRET LATHES.—Jones & Lamson Machine Company, Springfield, Vt. Three spiralbound booklets with illustrations and general specifications of ram type lathes, Nos. 3, 4 and 5, and saddle type lathes, 7a, 7b, and 7d, and 8a, 8b, and 8d, respectively.

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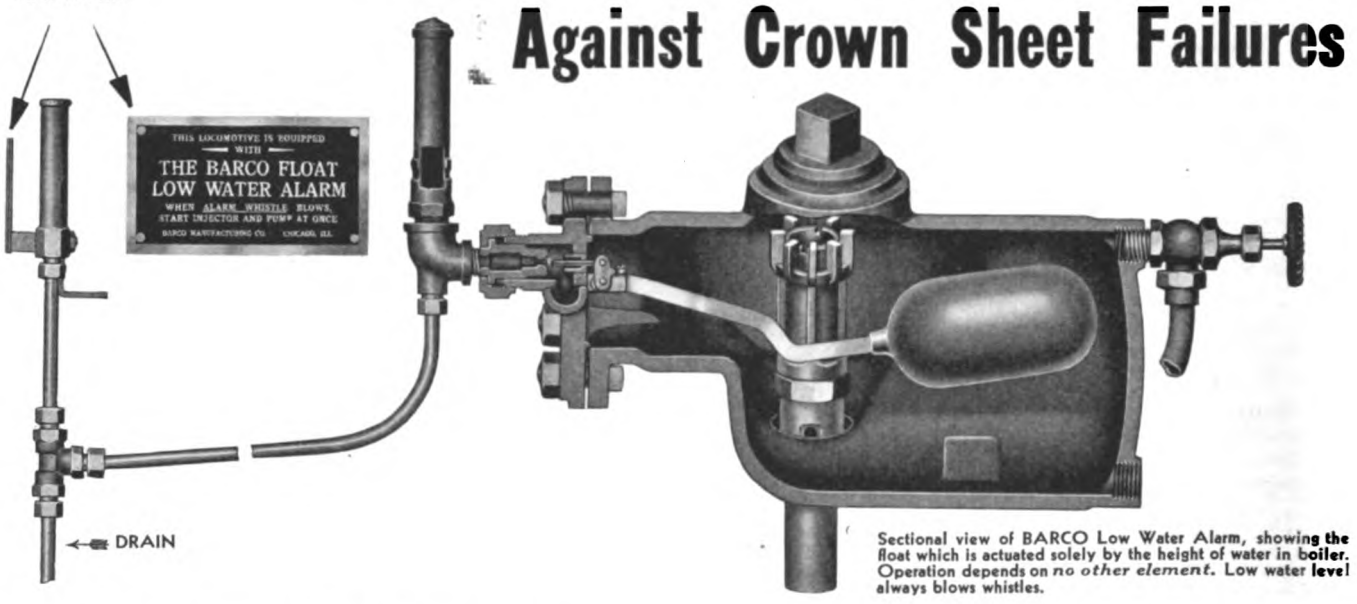
TONCAN IRON PIPE.—Republic Steel Corporation, Cleveland, Ohio. Forty-four pages, illustrated. Story of Toncan copper molybdenum iron pipe. Deals with manufacture, rust and corrosion resistance, physical properties, threading procedure, welding, sizes and weights, and outstanding installations and service records in specific fields.

◆

TOOL MANUAL.—Haynes Stellite Company, 205 East Forty-Second street, New York. "Haynes Stellite J-Metal Cutting Tools"—revised edition—brought up-to-date on many phases of cutting-tool practice. Includes a discussion of various tool bit holders and adaptors and describes new Haynes Stellite wear strips for driving and pilot bars. Recommends proper speeds and feeds for use of J-Metal tools in machining many materials under a wide variety of conditions.

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Sectional view of BARCO Low Water Alarm, showing the float which is actuated solely by the height of water in boiler. Operation depends on *no other element*. Low water level always blows whistles.

BARCO *Two-Whistle*
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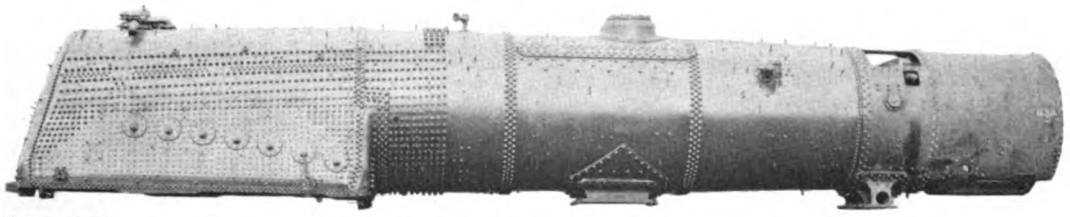
RAILWAY MECHANICAL ENGINEER

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With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, and Railway Master Mechanic. Name Registered, U. S. Patent Office.

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See page 43

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Locomotive:

A Study of the Locomotive Boiler ... 43
I. C. C. Locomotive Inspection Report ... 52
Baldwin Diesel-Electric Switchers ... 56

General:

USS Cor-Ten Versus Copper Steel ... 60

Car:

Denver & Rio Grande Western Automobile-Box Cars ... 62

Editorials:

Locomotive Availability ... 65
Steam and Diesel Locomotive Comparisons ... 65
The Designer Must Consider Maintenance ... 66
Boiler Explosions ... 66
Journal-Box Temperatures ... 67
New Books ... 67

Car Foremen and Inspectors:

Journal-Box Temperature ... 69
Improvements at the Readville Shops Facilitates Demounting Wheels ... 70
Air Brake Questions and Answers ... 73

Backshop and Enginehouse:

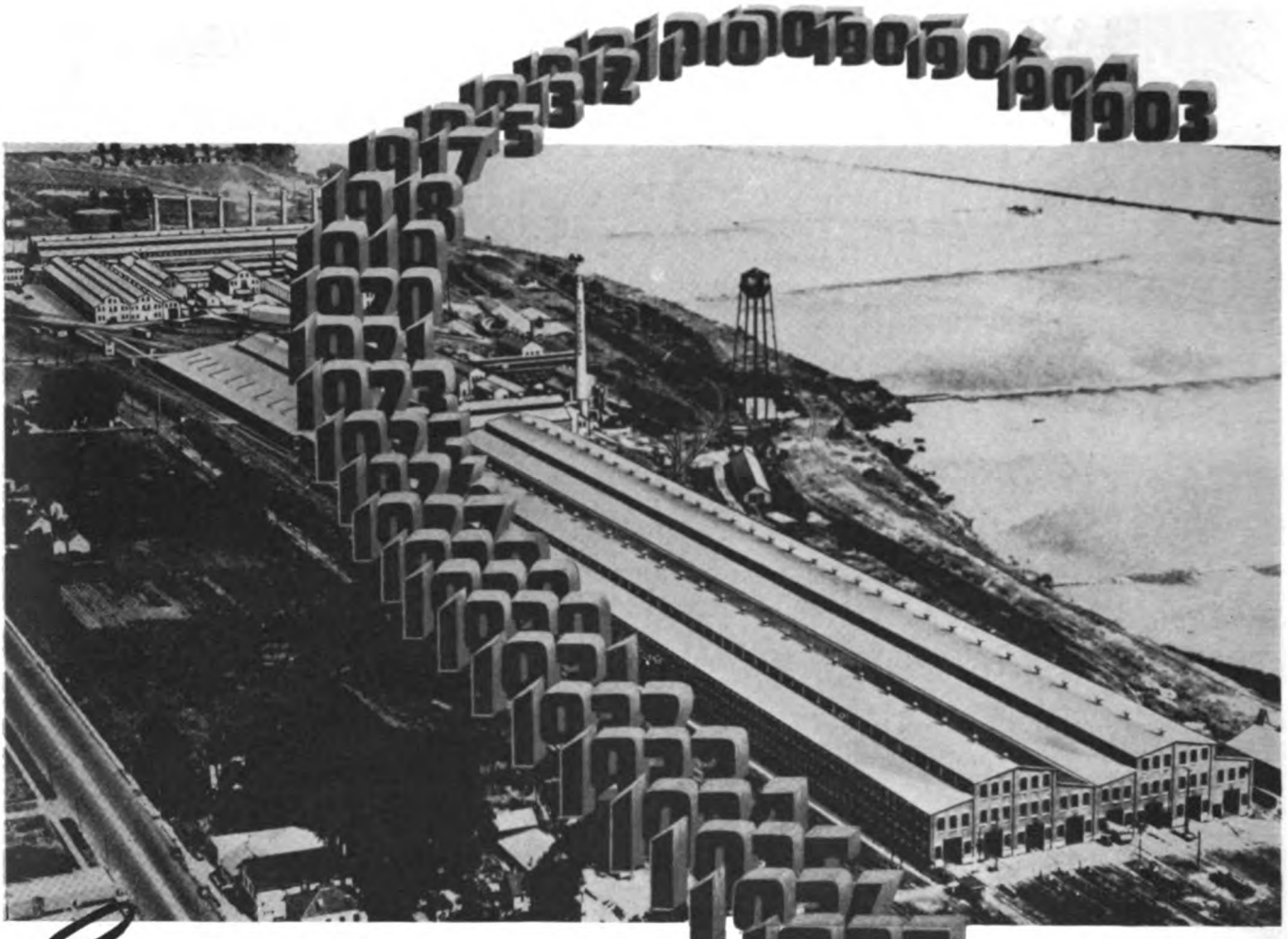
Rock Island Medallion ... 75
Tire-Turning Tool Has Cutter Control ... 75
Flue Repair Shop Designed for One-Man Operation ... 76
Applying Link Trunnion Bushings ... 78
Syphon Patch With a Spiral Seam ... 79
Hand-Feed Adapter for Operating Lathe Head ... 79
Universal Machine for External and Internal Grinding ... 79

High Spots in Railway Affairs ... 80

Clubs and Associations ... 81

News ... 82

Index to Advertisers ... (Adv. Sec.) 46



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RAILWAY
MECHANICAL ENGINEER

A Study of

The Locomotive Boiler*

By C. A. Brandt†

The author discusses some of the problems of boiler design and proportions that affect the efficiency and capacity of the conventional locomotive

THE public, which is served by the railroads, is continuously demanding higher speeds for both freight and passenger trains, and this, in conjunction with a more intensive utilization of their motive power, is one of the many important problems confronting the managements of the American railroads today. Until recent years the steam locomotive had been the principal power unit, but its supremacy is now being challenged by other forms of motive power, particularly the electric- and Diesel-driven locomotives. To meet this challenge the designers of steam locomotives are constantly studying the problem of building boilers of greater steam-generating capacity within the permissible limits of size and providing engines of lowest posible steam consumption per unit of power.

The fact that higher boiler capacity for minimum weight has been an ever-present problem throughout the years of locomotive development in America can best be illustrated by citing the evolution of the eight-coupled locomotive. The first of this design, or the 2-8-0, utilized 90 per cent of the total locomotive weight for adhesion. The demands for higher speeds, requiring greater steam-making capacity, led to the addition of truck axles to carry the heavier boilers, which resulted in the successive development of the 2-8-2, the 4-8-4, and last the 6-4-4-6 type high-speed locomotive, exhibited at the New York World's Fair this year.

The total weight of an early-design 2-8-0 type locomotive with 270,000 lb., on the drivers and a tractive force of 67,500 lb. was only 300,000 lb. To supply the steam for the high-speed 6-8-6 type locomotive with the same weight on drivers and the same tractive force, requires a boiler of such size as to double the total weight of the locomotive to 600,000 lb., as shown in the table.

Increase in Weight of Eight-Coupled Locomotives Due to Larger Boiler Capacity

Type	Tractive force, lb.	Weight on drivers, lb.	Total weight of loco., lb.	Weight on drivers, per cent of total	Increase in weight of locomotive to gain additional boiler power	
					Actual, lb.	Per cent
2-8-0	67,500	270,000	300,000	90	.....	..
2-8-2	67,500	270,000	360,000	75	60,000	20
4-8-2	67,500	270,000	400,000	67	100,000	33
4-8-4	67,500	270,000	450,000	60	150,000	50
6-4-4-6	67,500	270,000	600,000	45	300,000	100

As this and other modern locomotives are examples close to the maximum practical size that can be built, the important question is whether greater boiler efficiency is attainable, particularly at high-capacity operation, and what can be done to accomplish this.

The question of reducing the steam consumption of the engines is outside the scope of this paper, but the reduction of steam consumption per i. hp. from an average of 18 to 13 lb. is possible by the adoption of compound cylinders as reported from tests on French locomotives, as well as by the use of still higher superheat and valve gear adaptable for its utilization. This paper will be confined to a discussion of those problems of design believed to be most essential in the advancement of the art. To enhance the value of this contribution, Tables I to VI‡ are included which give the principal dimensions and boiler ratios of representative locomotives of various types built in America in recent years. Locomotive test curves are also presented.

The subject matter will be centered on problems affecting the design of the conventional locomotive fire-tube boiler only, not because of any belief that this type of boiler is the final answer to the locomotive steam generator, but because at present most of the locomotives in the world are equipped with this type of boiler. The best solutions to some of the problems encountered in the design of large boilers have not yet been agreed upon principally because of the lack of reliable test data. A committee of the Association of American Railroads submitted a report in 1939 recommending a conventional type of boiler for a proposed 6,400-hp. high-speed locomotive, which is an acknowledgment that the fundamental principles of this boiler design have proved practical and are the best available at the present time.

It is unnecessary to recite in detail the advantages of the conventional boiler; this has been done many times before. The virtues of the completely water-cooled radiant-heat-absorbing furnace, high gas velocities over the convection heating surfaces with forced draft, and high superheat, all originally inherent in the locomotive boiler, are now being recognized as essentials to efficient steam generation in other fields and are being rapidly adopted in stationary power-plant boilers.

Locomotive boilers of designs radically different from conventional construction have been built in the past, but so far none has proved sufficiently practical for general railroad service. There will soon be placed in service in America a different type of steam generator for operation in conjunction with condensing steam turbines, and still other types are under consideration.

* Paper presented on December 7, 1939, at the annual meeting of The American Society of Mechanical Engineers, at Philadelphia, Pa. This paper will be published in two parts, Part I appearing in this issue.

† Chief engineer, The Superheater Company.

‡ Tables I to III appear in this issue. Tables IV to VI will be published in a subsequent issue.

Table I—General Dimensions and Boiler Ratios of Six-Coupled Locomotives

1. Type	4-6-4	4-6-4	4-6-4	4-6-4	4-6-4	4-6-4	4-6-4	4-6-4	4-6-4	4-6-4
2. Railroad	C.P.R.	C.B.&Q.	N.Y.C.	N.Y.C.	Can.Nat.	N.Y. N.H.&H.	B.&O.	A.T.&S.F.	C.M. St.P.&P.	C.&N.W.
3. Road class	H-1-C	S-4	J-1-B	J-3-A*	K-5-A	I-5	V-2	3460†	F-7	E-4
4. Date built	1937	1930	1927	1938	1930	1937	1935	1937	1938	1938
5. Boiler pressure, lb. per sq. in.	275	250	225	275	275	285	350	300	300	300
6. Cylinder diameter and stroke, in.	22x30	25x28	25x28	22½x29	23x28	22x30	19x28	23½x29	23½x30	25x29
7. Driving wheels, diameter outside tires, in.	75	78	79	79	80	80	84	84	84	84
8. Weight on drivers, lb.	186,800	207,730	184,800	201,800	188,600	193,000	156,000	211,400	216,000	216,000
9. Total weight of engine, lb.	354,000	391,880	348,000	365,500	356,400	365,300	294,000	420,400	415,000	412,000
10. Tractive force, lb.	45,300	47,700	42,400	43,440	43,300	44,000	34,000	49,300	50,300	55,000
11. Boiler diameter, first course, inside, in.	78½	80 9/16	82 7/16	80⅝	78	82 7/16	72 O D	86 9/16	82½	88 3/16
12. Boiler diameter, largest, outside, in.	90⅛	94	87⅝	91½	85⅞	93	...	91 7/16	94	94
13. Length over tube sheets, ft.-in.	18-3	19-0	20-6	19-0	19-1	18-0	25-0	21-0	19-0	19-0
14. Combustion-chamber length, in.	27	36	...	43	31	42	36	...	44½	31
15. Grate area, sq. ft.	80.8	87.9	81.5	82.0	73.7	77.1	61.8	98.5	96.5	90.7
16. Tube and flue heating surface, sq. ft.‡	3,465	3,878	4,203	3,827	3,032	3,335	2,727	4,395	3,708	3,472
17. Firebox heating surface, sq. ft.‡	326	369	281	360	345	480	612	375	458	507
18. Total evaporative heating surface, sq. ft.‡	3,791	4,247	4,484	4,187	3,377	3,815	3,339	4,770	4,166	3,979
19. Superheater surface, steam side, sq. ft.	1,542	1,830	1,965	1,745	1,492	1,042	880	2,150	1,695	1,884
20. Firebox volume, cu. ft.	427	494	353	452	362	448	...	483	503	560
21. Gas area through boiler, sq. ft.	8.38	9.00	9.66	8.90	7.04	8,92	4.61	9.10	9.14	8.07
22. Type of superheater	E	E	E	E	E	A	A	E	E	E
23. Steam area through superheater, sq. in.	60.6	65.6	64.2	61.8	52.2	54.7	44.8	71.2	63.6	67.7
24. Maximum evaporation, calculated, lb. per hr.	55,960	61,710	57,770	60,500	51,600	64,000	55,480	64,780	65,400	65,740
25. Maximum evaporation, on test, lb. per hr.	...	...	84,800	...	...	...	...	...	...	...
26. Flues, number and diameter, in.	171-3½	184-3½	182-3½ 19-3½	183-3½	146-3½	48-5½	27-5½	200-3½	164-3¾	196-3½
27. Tubes, number and diameter, in.	58-2¼	62-2¼	37-2¼	59-2¼	44-2¼	199-2¼	120-2¼	46-2¼	60-2¼	8-2
28. Superheater units, number and diameter, in.	86-1 9/16	93-1 13/16	91-1 13/16	93-1 13/16	74-1 13/16	48-1½	27-1¾	101-1 13/16	84-1¼	102-1 13/16
29. Gas area per 1,000 lb. tractive force, sq. ft.	.185	.189	.228	.206	.163	.203	.136	.185	.182	.147
30. Gas area per sq. ft. of grate, sq. ft.	.104	.103	.119	.109	.096	.116	.075	.093	.095	.089
31. Gas area per sq. ft. of tube and flue heating surface, sq. ft.	.00242	.00232	.00230	.00233	.00232	.00268	.00169	.00207	.00246	.00233
32. Grate per 1,000 lb. tractive force, sq. ft.	1.79	1.85	1.92	1.89	1.71	1.75	1.82	2.00	1.92	1.65
33. Grate per sq. ft. total evaporative heating surface, sq. ft.	.0214	.0208	.0181	.0196	.0219	.0202	.0185	.0207	.0232	.0228
34. Firebox volume per 1,000 lb. tractive force, cu. ft.	9.43	10.60	8.34	10.40	8.35	10.20	...	9.80	10.00	10.20
35. Firebox volume per sq. ft. of gas area, cu. ft.	51.0	54.9	36.6	50.8	51.4	50.2	...	53.1	55.1	69.4
36. Firebox volume per sq. ft. of grate, cu. ft.	5.29	5.61	4.34	5.51	4.91	5.81	...	4.90	5.22	6.16
37. Firebox volume per sq. ft. total evaporative heating surface, cu. ft.	113.0	116.2	78.5	108.0	107.5	117.5	...	101.1	121.0	141.0
38. Firebox heating surface per sq. ft. of grate, sq. ft.	4.03	4.20	3.45	4.40	4.68	6.23	9.90	3.81	4.75	5.59
39. Firebox heating surface per sq. ft. total evap. heating surface x 100, sq. ft.	8.60	8.70	6.25	8.60	10.2	12.60	18.35	7.85	11.0	12.75
40. Total evap. heating surface per 1,000 lb. tractive force, sq. ft.	83.6	89.0	105.9	96.3	77.8	86.6	98.1	96.8	82.9	72.4
41. Total evap. heating surface per sq. ft. of grate, sq. ft.	46.9	48.3	55.1	51.1	45.8	49.5	54.0	48.5	43.3	43.8
42. Superheat. surface per sq. ft. total evap. heat. surface, sq. ft.	.407	.431	.438	.417	.442	.274	.264	.450	.406	.474
43. Gas area through flues, per cent	84.8	85.0	80.1	85.5	86.1	51.0	42.6	89.0	86.1	98.3
44. Weight on drivers per 1,000 lb. tractive force, lb.	4,120	4,350	4,360	4,640	4,350	4,390	4,590	4,285	4,300	3,925
45. Total weight of engine per 1,000 lb. tractive force, lb.	7,810	8,200	8,210	8,425	8,245	8,300	8,640	8,550	8,250	7,490

* Streamline locomotive. † Locomotive number. ‡ Water side.

There has been a great increase in the size of locomotive boilers built in recent years in America; many of these have proved very efficient. However, much remains to be done to make possible the burning of more fuel per hour at higher combustion efficiency with lower draft loss, greater heat-absorption efficiency and higher superheat with less boiler weight per pound of steam produced.

Definition of Boiler Capacity and Existing Formulas

In designing a locomotive, the steam required for a given maximum horsepower capacity can be determined quite accurately from existing knowledge of steam consumption per i. hp.-hr., when initial and final steam conditions are specified. To this must be added the steam required for auxiliaries, train heating, air conditioning and other uses. The boiler design must be such as to deliver this maximum steam output at a superheat as high and a back pressure as low as that figured on, or else the steam consumption per i. hp. will increase and the cylinder power fall below that required. To determine the excellence of a particular boiler design and compare it with others, it is necessary to have a standard measure of comparison.

It would appear logical that the weight of steam produced per pound of total weight of the boiler in service should provide a satisfactory measure when a definite steam pressure, superheat, and draft loss are specified. It is obvious that such a yardstick is of no value, unless a standard method of predetermining the maximum evaporative capacity is found which will satisfy all conditions in a reasonable way.

In reviewing the existing methods of calculating the maximum evaporating capacity of a locomotive boiler and the over-all boiler efficiency, the designer is confronted with the fact that formulas now generally used are inadequate for predetermining the result with accuracy, particularly when large boilers are involved. In America the theory generally followed is that the

Table II—General Dimensions and Boiler Ratios of Ten-Coupled Locomotives

1. Type	2-10-0	2-10-2	2-10-2 N.Y.	2-10-4	2-10-4	2-10-4	2-10-4	2-10-4	2-10-4	4-10-2
2. Railroad	P.R.R.	Can.Nat.	N.H.&H.	Cent.Ver.	C.P.R.	C.B.&Q.	C.&O.	K.C.S.	A.T.&S.F.	B.L.W.
3. Road class	I1S*	T4B	L1C	T3A	T1B	M4†	T1	J	5001	60,000
4. Date built	1922	1930	1929	1928	1938	1927	1930	1937	1938	1926
5. Boiler pressure, lb. per sq. in.	250	275	200	250	285	250	260	310	310	350
6. Cylinder diameter and stroke, in.	30½x32	24x28	30x32	27x32	25x32	31x32	29x34	27x34	30x34	27x32‡
7. Driving wheels, diameter outside tires, in.	62	57	63	60	63	64	69	70	74	63½
8. Weight on drivers, lb.	352,500	261,040	301,800	285,000	309,900	353,820	373,000	350,000	371,680	338,400
9. Total weight of engine, lb.	386,100	344,170	363,325	419,000	447,000	512,110	566,000	509,000	545,260	457,500
10. Tractive force, lb.	90,024	61,600	77,800	76,800	76,905	90,000	91,584	93,300	93,000	82,500
11. Boiler diameter, first course, inside, in.	82	74⅛	88	84½	82½	90	98	90	92¼	81⅛
12. Boiler diameter, largest, outside, in.	93	86	92 13/16	94	96½	104	108	102	104	94
13. Length over tube sheets, ft.-in.	19-1	19-3	18-0	22-0	21-0	21-6	21-0	21-0	21-0	23-0
14. Combustion-chamber length, in.	42¼	37	...	48	54	49½	66	75	72	...
15. Grate area, sq. ft.	70.0	66.7	82.0	84.4	93.5	106.5	121.7	107.0	121.5	82.5
16. Tube and flue heating surface, sq. ft.§	4,303	3,059	3,951	4,280	4,642	5,455	5,990	4,654	5,443	4,420
17. Firebox heating surface, sq. ft.§	287	347	454	423	412	449	645	500	632	342
18. Total evaporative heating surface, sq. ft.§	4,590	3,406	4,405	4,703	5,054	5,904	6,635	5,154	6,075	4,762
19. Superheater surface, steam side, sq. ft.	1,575	1,500	1,945	2,220	2,032	2,487	3,030	2,075	2,675	1,357
20. Firebox volume, cu. ft.	364	386	422	458	...	670	826	722	745	683
21. Gas area through boiler, sq. ft.	9.90	7.05	9.95	8.70	9.75	11.10	12.75	10.35	11.55	9.37
22. Type of superheater	E	E	E	E	E	E	E	E	E	A
23. Steam area through superheater, sq. in.	49.0	52.2	71.9	69.1	65.1	78.3	97.3	70.4	89.6	56.9
24. Maximum evaporation, calculated, lb. per hr.	56,660	51,750	69,000	65,110	69,120	78,520	96,210	74,680	89,140	60,410
25. Maximum evaporation, on test, lb. per hr.	65,257	...	65,750	...	...	78,710	...	...	...	69,695
26. Flues, number and diameter, in.	170-3½	146-3½	204-3½	192-3½	196-3½	222-3½	375-3½	183-3¼	249-3½	50-5½
27. Tubes, number and diameter, in.	120-2¼	44-2¼	57-2¼	33-2¼	72-2¼	87-2¼	59-2¼	73-2¼	56-2¼	206-2¼
28. Superheater units, number and diameter, in.	85-1⅛	74-1 9/16	102-1 9/16	98-1 9/16	98-1 9/16	111-1 9/16	138-1 9/16	93-1¼	127-1 9/16	50-1½
29. Gas area per 1,000 lb. tractive force, sq. ft.	.110	.114	.128	.113	.127	.123	.139	.111	.124	.114
30. Gas area per sq. ft. of grate, sq. ft.	.141	.106	.122	.103	.104	.104	.105	.097	.095	.114
31. Gas area per sq. ft. of tube and flue heating surface, sq. ft.	.00230	.00231	.00252	.00203	.00211	.00204	.00213	.00222	.00212	.00212
32. Grate per 1,000 lb. tractive force, sq. ft.	.78	1.08	1.06	1.10	1.22	1.18	1.33	1.15	1.31	1.00
33. Grate per sq. ft. total evaporative heating surface, sq. ft.	.0153	.0196	.0186	.0179	.0185	.0181	.0184	.0207	.0200	.0173
34. Firebox volume per 1,000 lb. tractive force, cu. ft.	4.04	6.26	5.42	5.96	...	7.44	9.02	7.75	8.01	8.29
35. Firebox volume per sq. ft. of gas area, cu. ft.	36.8	54.8	42.4	52.6	...	60.3	64.9	69.8	64.5	73.0
36. Firebox volume per sq. ft. of grate, cu. ft.	5.20	5.78	5.15	5.43	...	6.20	6.79	6.75	6.13	8.28
37. Firebox volume per sq. ft. total evaporative heating surface, cu. ft.	79.3	113.5	95.8	97.4	...	113.5	124.7	140.0	112.5	144.0
38. Firebox heating surface per sq. ft. of grate, sq. ft.	4.10	5.20	5.54	5.02	4.41	4.22	5.31	4.67	5.20	4.15
39. Firebox heating surface per sq. ft. total evap. heating surface x 100, sq. ft.	6.25	10.20	10.30	8.98	8.13	7.61	9.72	9.70	10.40	7.18
40. Total evap. heating surface per 1,000 lb. tractive force, sq. ft.	51.0	55.3	56.7	61.2	65.8	65.6	72.4	55.3	65.4	57.7
41. Total evap. heating surface per sq. ft. of grate, sq. ft.	65.5	51.1	53.7	55.8	54.1	55.4	54.5	48.2	50.0	57.8
42. Superheat. surface per sq. ft. total evap. heat. surface, sq. ft.	.343	.440	.441	.472	.401	.422	.457	.402	.440	.285
43. Gas area through flues, per cent	73.2	86.1	...	91.7	83.7	83.2	89.6	84.8	89.5	51.6
44. Weight on drivers per 1,000 lb. tractive force, lb.	3,920	4,240	3,870	3,710	4,020	3,925	4,070	3,775	3,985	4,100
45. Total weight of engine per 1,000 lb. tractive force, lb.	4,290	5,290	4,670	5,460	5,814	5,690	6,185	5,460	5,870	5,540

* No. 790. † No. 6320. ‡ One high-pressure and two low-pressure cylinders. § Water side.

steam-generating capacity[1] of a boiler is directly proportional to the amount of evaporating heating surface in square feet. A set of evaporative values, giving the maximum quantity of steam in pounds per square foot of heating surface per hour, generated by the firebox and flues, was prepared some years ago by F. J. Cole.[2] These values are generally used by the locomotive builders and railroads today.[1,2,3,4]

Any method of calculation that takes square feet of heating surface only into consideration must be inadequate. It is evident that the arrangement of the heating surfaces, their relationship to the grate area, furnace volume, gas area, firebox heating surface and hydraulic depth and length of the flues must be considered to give approximately correct results. The reason is that it is these relationships which determine the boiler efficiency, the back pressure required to produce the steam, and the superheat, all of which have a great influence on the efficiency and power output of the cylinders.

Strahl proposed a formula in 1913[5] which takes into consideration the size of the grate area and its ratio to the evaporating heating surface

$$WS = \frac{a}{\frac{S}{R} + 7} \times S$$

where

WS = total steam produced, lb. per hr.
R = grate area, sq. ft.
S = evaporating heating surface, sq. ft.
a = coefficient for superheated locomotive, 778 lb. per sq. ft.

[1] "Locomotive Data," The Baldwin Locomotive Works, eleventh edition, Philadelphia, Pa., 1939, pp. 21-23.
[2] "Locomotive Handbook," American Locomotive Company, Schenectady, N. Y., 1917, p. 58.
[3] "Potential Horsepower Formula Agreed to by American Locomotive Builders," Report of Federal Co-Ordinator of Transportation, Washington, D. C., Nov. 27, 1935, p. 48.
[4] "Horsepower and Tractive Effort of the Steam Locomotive," by A. I. Lipetz, Trans. A. S. M. E., vol. 55, RR-55-2, 1933, pp. 5-42.
[5] "Method of Determining the Capacity of Steam Locomotives," by Strahl, *Zeit V. D. I.*, vol. 57, 1913, pp. 251-257, 326-332, 379-386, 421-424.

Table III—General Dimensions and Boiler Ratios for Eight-Coupled Locomotives

1. Type	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4
2. Railroad	N.C.&St.L.	D.& R.G.W.	St.L.-S.W.	L.V.	Wabash	C.&O.	Can.Nat.	Sou.Pac.	Gt.Nor.	D.& R.G.W.
3. Road class	J2	M64	L1	T-2	O1	J3	U2D	GS2	S1	M68
4. Date built	1930	1929	1937	1931	1930	1935	1936	1936	1929	1937
5. Boiler pressure, lb. per sq. in.	250	240	250	255	250	250	250	250	250	285
6. Cylinder diameter and stroke, in.	25x30	27x30	26x30	26x32	27x32	27½x30	25½x30	27x30	28x30	26x30
7. Driving wheels, diameter outside tires, in.	70	70	70	70	70	72	73	73½	73	73
8. Weight on drivers, lb.	220,000	252,000	248,000	268,000	274,100	273,000	237,600	266,500	273,700	279,172
9. Total weight of engine, lb.	381,000	408,500	425,500	422,000	454,090	477,000	390,000	448,400	472,120	479,360
10. Tractive force, lb.	57,000	63,700	61,500	66,700	70,750	66,960	56,800	62,200	67,000	67,200
11. Boiler diameter, first course, inside, in.	79	82 15/16	84½	84¼	86½	90	80⅞	84¼	86 1/16	90 9/16
12. Boiler diameter, largest, outside, in.	92	96	98	98	100	100	90	96	98	100
13. Length over tube sheets, ft.-in.	20-6	22-0	20-0	21-6	21-0	21-0	21-6	21-6	22-0	21-0
14. Combustion-chamber length, in.	54	42	54	54	50	54	48½	60	52	72
15. Grate area, sq. ft.	77.3	88.0	88.3	88.3	96.2	100.0	84.3	90.4	102.0	106.0
16. Tube and flue heating surface, sq. ft.*	3,751	4,473	4,259	4,933	4,694	5,013	3,805	4,502	5,004	4,952
17. Firebox heating surface, sq. ft.*	444	446	469	508	495	525	415	350	401	555
18. Total evaporative heating surface, sq. ft.*	4,195	4,919	4,728	5,441	5,189	5,538	4,220	4,852	5,405	5,507
19. Superheater surface, steam side, sq. ft.	1,837	2,229	1,962	2,256	2,360	2,342	1,760	2,086	2,420	2,336
20. Firebox volume, cu. ft.	478	402	...	567	...	642	408	559	...	690
21. Gas area through boiler, sq. ft.	8.11	9.04	9.24	10.10	9.70	10.60	7.86	9.13	10.08	10.43
22. Type of superheater	E	E	E	E	E	E	E	E	E	E
23. Steam area through superheater, sq. in.	63.5	69.8	67.7	71.9	75.4	74.4	56.4	67.1	74.0	74.4
24. Maximum evaporation, calculated, lb. per hr.	63,040	68,280	70,100	76,500	74,780	79,640	60,810	63,575	70,570	80,800
25. Maximum evaporation, on test, lb. per hr.	...	...	...	...	...	...	...	...	...	...
26. Flues, number and diameter, in.	169-3½	195-3½	200-3½	202-3½	214-3½	220-3½	167-3½	198-3½	210-3½	222-3½
27. Tubes, number and diameter, in.	49-2¼	43-2¼	52-2¼	77-2¼	49-2¼	65-2¼	42-2¼	49-2¼	61-2¼	57-2¼
28. Superheater units, number and diameter, in.	86-1 9/16	99-1 9/16	102-1 9/16	102-1 9/16	107-1 9/16	112-1 9/16	85-1 9/16	101-1 9/16	105-1 9/16	112-1 9/16
29. Gas area per 1,000 lb. tractive force, sq. ft.	.142	.142	.151	.151	.137	.158	.139	.147	.150	.155
30. Gas area per sq. ft. of grate, sq. ft.	.105	.103	.105	.114	.101	.106	.093	.101	.099	.099
31. Gas area per sq. ft. of tube and flue heating surface, sq. ft.	.00216	.00202	.00217	.00205	.00207	.00211	.00207	.00203	.00201	.00211
32. Grate per 1,000 lb. tractive force, sq. ft.	1.36	1.38	1.44	1.33	1.36	1.50	1.48	1.45	1.52	1.58
33. Grate per sq. ft. total evaporative heating surface, sq. ft.	.0184	.0179	.0187	.0163	.0186	.0188	.0200	.0186	.0188	.0192
34. Firebox volume per 1,000 lb. tractive force, cu. ft.	8.38	6.31	...	8.50	...	9.60	7.15	9.00	...	10.30
35. Firebox volume per sq. ft. of gas area, cu. ft.	58.9	44.5	...	56.1	...	60.6	51.7	61.3	...	66.1
36. Firebox volume per sq. ft. of grate, cu. ft.	6.18	4.57	...	6.43	...	6.42	4.83	6.19	...	6.50
37. Firebox volume per sq. ft. total evaporative heating surface, cu. ft.	114.1	81.8	...	104.1	...	116.0	96.4	115.2	...	125.2
38. Firebox heating surface per sq. ft. of grate, sq. ft.	5.74	5.07	5.33	5.75	5.15	5.25	4.93	3.88	3.93	5.24
39. Firebox heating surface per sq. ft. total evap. heating surface x 100, sq. ft.	10.60	9.05	9.92	9.33	9.52	9.50	9.84	7.20	7.40	10.07
40. Total evap. heating surface per 1,000 lb. tractive force, sq. ft.	73.6	77.3	76.9	81.5	73.3	82.7	74.3	78.2	80.8	81.9
41. Total evap. heating surface per sq. ft. of grate, sq. ft.	54.3	55.9	53.5	61.6	54.0	55.4	50.1	53.8	53.0	51.9
42. Superheat. surface per sq. ft. total evap. heat. surface, sq. ft.	.438	.453	.415	.414	.455	.424	.417	.429	.448	.424
43. Gas area through flues, per cent	87.0	85.4	88.0	83.2	89.3	86.4	88.0	88.0	86.5	88.3
44. Weight on drivers per 1,000 lb. tractive force, lb.	3,860	3,950	4,030	4,020	3,880	4,077	4,180	4,280	4,080	4,150
45. Total weight of engine per 1,000 lb. tractive force, lb.	6,680	6,420	6,920	6,325	6,420	6,220	6,865	7,220	7,050	7,140

* Water side.

This formula, with the coefficients established by Strahl, comes close to test results on boilers with proportions similar to those which Strahl used in his analysis, but leads to unsatisfactory results on boilers with different ratios. The Strahl formula may be modified to suit different arrangements by changing the coefficients to suit, but this is not an entirely sound procedure.

Comparison of Evaporation Calculated by Different Methods with Actual Test Results

	Evaporation, lb. per hr.				
Locomotive	Strahl	Cole	Difference, per cent	Actual test	Difference, per cent
Penna. K4S No. 5341	48,000	52,150	+ 8.6	72,000	+50
Penna. M1A No. 6706	53,350*	67,850*	+27.2	99,095*	+85.7
N. Y. C. J3A	60,700*	60,500*	− 0.3	85,000*	+40

* With feedwater heater.

A method originated by Lawford H. Fry[6] for determining the maximum evaporating capacity of a boiler from the over-all boiler-efficiency curve appears to be a better approach. Fry suggested that, if the over-all boiler efficiency is plotted against pounds of coal or total heat in B.t.u. fired per sq. ft. of grate per hour, the relationship between the efficiency and rate of firing becomes a straight line. The correctness of this theory has been proved on tests examined. The fundamental equation established by Fry is

$$F = m - nG$$

where

F = boiler efficiency, per cent
G = dry coal fired, lb. per sq. ft. of grate per hr.
m = coefficient denoting theoretical efficiency at zero firing rate
n = coefficient determining slope of curve

If sufficient test data were available for all kinds of fuel and types of boilers so that the coefficients m and n or the origin and slope of the over-all boiler-efficiency curve could be predetermined with accuracy, together with the superheat and pressure at the outlet of the

[6] "A Study of the Locomotive Boiler," by Lawford H. Fry, Simmons-Boardman Publishing Corporation, New York, N. Y., 1924.

superheater, then the evaporation for any quantity of coal fired could be determined, as well as the maximum capacity.

It appears to the author that the Fry or other methods proposed do not satisfy the requirement as they stand, because draft loss and back pressure are not part of the picture. The inadequacies of both the Cole and Strahl methods are apparent when a comparison is made between the data calculated by the different methods, and the actual test results as shown in the table.

The author called attention to this some twelve years ago.[7] As far as is known, however, no tests have been made of locomotives of greatly varying boiler ratios and types of fuels to establish a satisfactory formula which may be used universally and permit evaluation of the effect that varying proportions have upon the economics of boiler performance and costs.

Boiler Tests

In its 1936 report, the A.A.R. Committee on Locomotive Construction expressed the opinion that the Cole ratios were inadequate and recommended approval

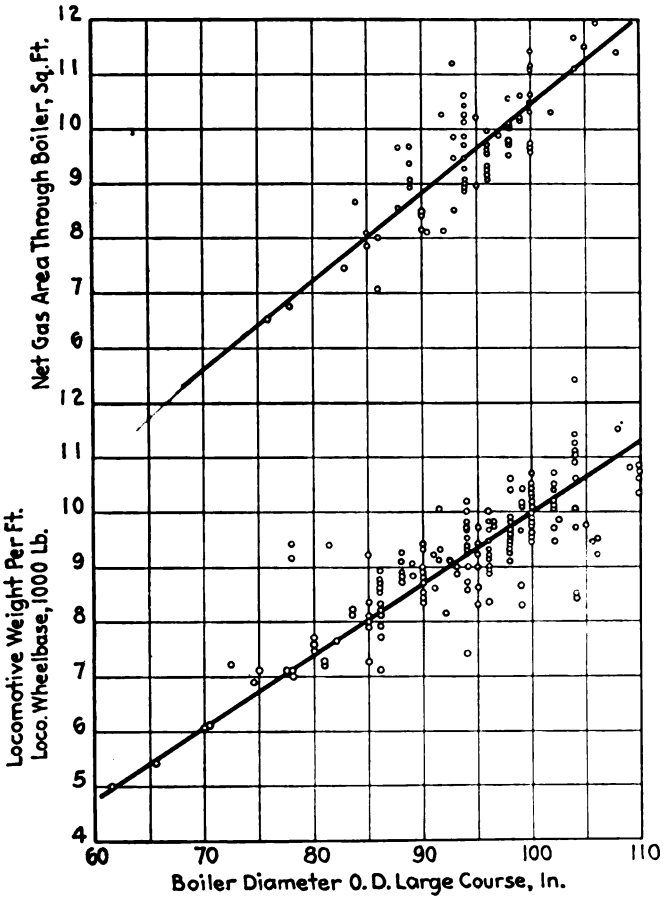


Fig. 1—The relation of boiler diameter to total weight of locomotive and to the gas area

of plant tests to obtain necessary data. The director of equipment research at that time, L. W. Wallace, made a report and recommended complete locomotive tests, but this program has never been carried out.

Many tests have been made by the Pennsylvania and the New York Central and the respective managements deserve the greatest praise for their valuable contributions to the art. Most of these tests, however, have been made on locomotives with relatively small grate areas, and with approximately the same ratios of grate areas, gas areas, firebox volumes, etc. There are few data available on the effects of very large grates and large fireboxes.

The tests recommended by the Research Division of the A.A.R. were complete and necessarily expensive. It is believed by the author that adequate information as to the efficiency and maximum capacity of boilers with large grates and furnaces can be obtained with stationary blowdown tests of some three or four boilers with widely different boiler ratios. Such tests should be conducted with oil fuel and also with several different grades of coal, sufficient to establish fundamental data now lacking. With complete data on the quantities, qualities, etc., of the fuel, water and air used, and the gases and steam produced, all losses could be segregated and closely determined.

This would permit the determination of coefficients m and n in Fry's formula. It is hoped that such a test program will be made possible as this matter is not one merely of academic importance, but is a vital item of railroad economics. The method of standing blowdown tests developed and used by the New York Central in recent years has proved very effective. This method of blowdown tests is conducted so that the steam exhausted from the cylinders through the nozzle is desuperheated to a temperature closely agreeing with that actually observed on road tests for equal capacities. The correctness of this test procedure has been proved by the fact that the front-end design and nozzle size established by such test have proved correct for best maximum performance in road service.

Gas Area in Relation to Boiler Efficiency and Capacity

It is well known that the efficiency of the boiler decreases with an increased firing rate. The rapid drop is mainly due to the high losses occurring in the form of unburned fuel escaping with the flue gases. The problem of greater fuel-burning capacity at higher efficiency of combustion is, therefore, the first item which should be considered and involves the arrangement and relative size of the gas area through the boiler, the grate area, combustion volume of the furnace, and the firebox heating surface, also, stoker construction, arrangement of firebrick arches, amount of air opening through the grates, and the introduction of secondary air above the fire bed.

In considering the matter of locomotive-boiler design, as in the case of any other structure, it is well to establish a base from which to start. This is difficult with a locomotive because the problem of its design involves a cycle of successive approximations to obtain maximum power and efficiency within the weight limitations.

In the past either the heating surface or the grate area has been the basis on which the size of the other component parts of the boiler has been determined. This is not the most logical procedure as the dimensions of these parts do not control the limit of size to which the boiler can be built, since they may be increased with the length of the boiler within considerable limits. The diameter and gas area through the boiler constitute the limiting factors because the height, width, and weight are fixed and cannot be exceeded. It is, therefore, more logical that this factor be made the basis on which the other parts are proportioned.

The capacity of the locomotive boiler is limited by its diameter because this determines the gas area of the flues through which all the gases of combustion must pass; in addition it must provide space for the super-

[7] "The Design and Proportion of Locomotive Boilers and Superheaters," by C. A. Brandt, Proceedings of the Canadian Railway Club, vol. 27, Feb., 1928, pp. 20-64.

heater through which all the steam generated must flow. It determines the flue heating surface that can be installed per unit length of flue, the area of the steam-disengaging surface and the steam volume above the water level in the boiler. This last item is of the greatest importance and is, in reality, the limiting factor in high-output operation, as evidenced by the serious difficulties experienced with water carry-over into the superheater and cylinders in many boilers.

Within the clearance, the maximum diameter of the boiler is determined by the weight limits. In order to analyze this problem, the proportions of 165 different designs of modern locomotives have been studied to ascertain the relationship between the diameter of the boiler and the total weight of the locomotive. The curve in Fig. 1 shows this relationship. It is apparent that, while there are many factors which influence the weight, the boiler diameter has been sacrificed for other features of design in many cases. If, as an example, the 104-in. boiler is noted, the total locomotive weight per foot will vary from a minimum of 8,400 lb. to a maximum of 12,400 lb., or an increase in total locomotive weight of nearly 50 per cent for the same boiler diameter. The chart indicates that there is a uniform increase of 133 lb. per ft. of total locomotive weight for every one-inch increase in the boiler diameter. This curve may facilitate studies in efforts to obtain the greatest possible diameter and gas area for allowable weights.

A relatively large gas area through the boiler in relation to the grate area and heating surface is not generally followed, as noted from a study of the ratios Nos. 29, 30 and 31, Tables I to VI.

That the gas area through the boiler is one of the most important items affecting the boiler capacity is not generally appreciated, but may be better understood if actual test figures are analyzed. From the test of the Pennsylvania M1A, Locomotive No. 6706, on which sufficient data are available to permit determination of the weight of the gases passing through the boiler, the data shown in Fig. 2 have been compiled. It is interesting to note that, at high firing rates, the gas velocity through the tubes near the back tube sheet reaches the high figure of 204 miles per hour. The great importance of eliminating unnecessary restrictions in the gas passages and the superheater units is apparent.

As the gas area is increased, the velocity and frictional resistance of the gases passing into and through the boiler flues are lowered. This will reduce the draft requirement and in turn the cylinder back pressure, en-

Total Coal Fired, Lb. Per Hour	Total Combustion Gases, Lb. Per Hour	Velocity of Gases, Miles Per Hour			
		Section			
		A	B	C	D
8,975	99,000	135	46	35	107
23,636	158,000	263	92	70	204

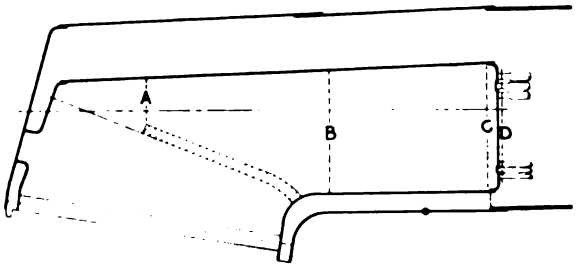


Fig. 2—Gas velocities through the locomotive firebox and flues

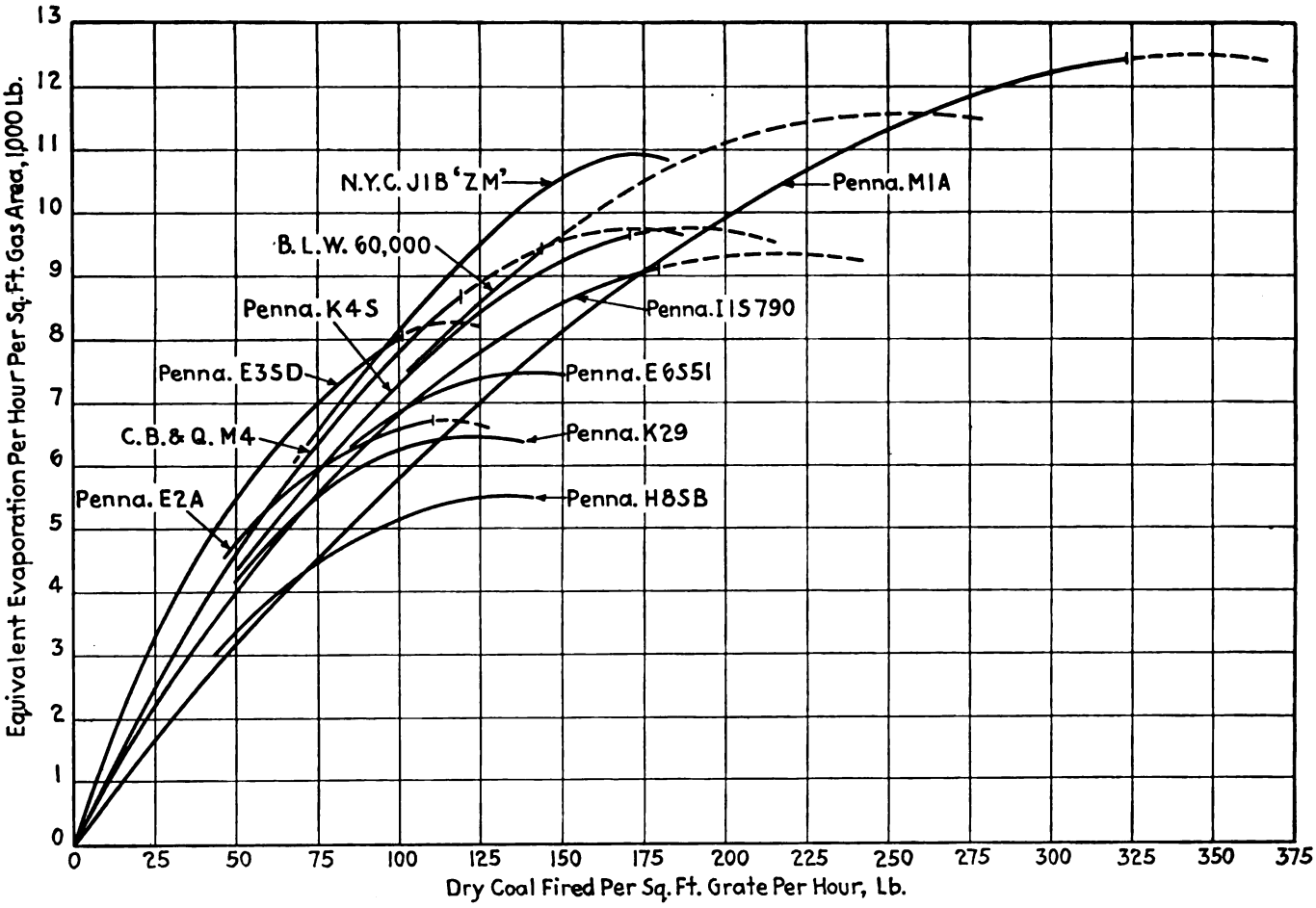


Fig. 3—Equivalent evaporation per sq. ft. of gas area versus coal per sq. ft. of grate

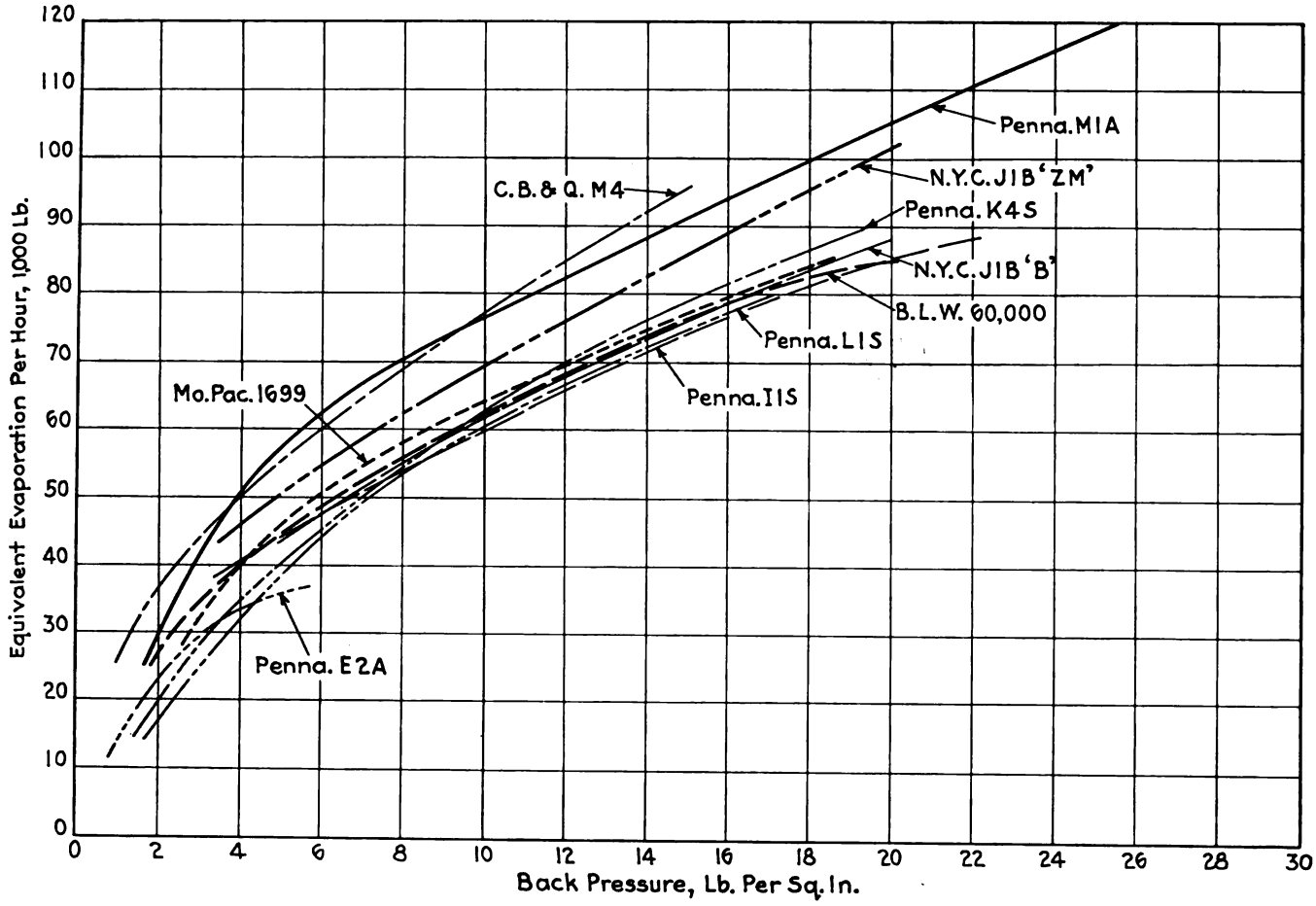


Fig. 4—Equivalent evaporation versus back pressure

larging the power output of the locomotive in direct proportion to the resultant increase in the m.e.p. This is important when high power output is desired at high speed as the reduction of 1 lb. of cylinder back pressure gives as much increase in power as a 4-lb. gain in pressure on the steam-inlet or admission side.

The importance of a large gas area through the boiler was recognized years ago. C. D. Young[8] pointed out in 1915 that from his experience the maximum evaporative capacity of a boiler was in direct ratio to the total gas area through the flues and was apparently limited to an amount 7,000 lb. actual or 9,100 lb. equivalent evaporation per hr. per sq. ft. of gas area for the engines tested up to that time. This has been bettered considerably on modern locomotives with type-E superheaters and more powerful draft arrangements to about 11,000 lb. equivalent evaporation per sq. ft. of gas area. To illustrate the limiting effect that the gas area has upon the evaporative capacity of a locomotive boiler, the test results from several locomotives have been plotted in Fig. 3. The relation between equivalent evaporation and back pressure is illustrated in Fig. 4.

A study of the relationship between the gas area and the boiler diameter of a number of modern boilers has been plotted in Fig. 1 and it will be noted that full advantage has not been taken in many cases in providing the largest possible gas area. For some boiler diameters the gas area is as much as 31½ per cent smaller than the maximum possible. This is perhaps due to a difference of opinion as to the most suitable distance between the top of the crown sheet and the inside of the boiler shell at the top; as to the water space between the combustion chamber and the boiler shell, or the clearance between tube holes and tube-sheet flanges; and as to tube spacing. The type of combustion chamber, the thickness of the flues and the superheater design also influence the gas area. Offhand, it may seem that these details are not of great consequence, but really they are very important.

The distance between the top of the crown sheet and the boiler shell determines the steam space and steam-disengaging surface. It is obvious that the smaller this distance is made the greater will be the tube-sheet area. Information as to the most satisfactory relationship between the height of the crown sheet and other dimensions of the boiler is lacking, but this question deserves most careful consideration.

A slight increase in the water space between the combustion chamber and boiler shell decreases the available gas area considerably. On some boilers, this water space has been made as large as 8 in., while very many large boilers are operating successfully with a water space of only 5 in., giving a large percentage increase in gas area. It appears that the smaller water space imparts a higher velocity to the water circulation at this point, minimizing mud collection which the large water space was supposed to eliminate.

Firebox Volume in Relation to Combustion Efficiency

Earlier in this paper, it was pointed out that the firebox volume is not subject to such limitations as the gas area. There are limitations to the width and height of the firebox which are important, but the length of the grate and firebox may be extended considerably beyond present general practice. This is fortunate as the most

[8] Test Bulletin, No. 28, Pennsylvania Railroad, 1915, p. 35.

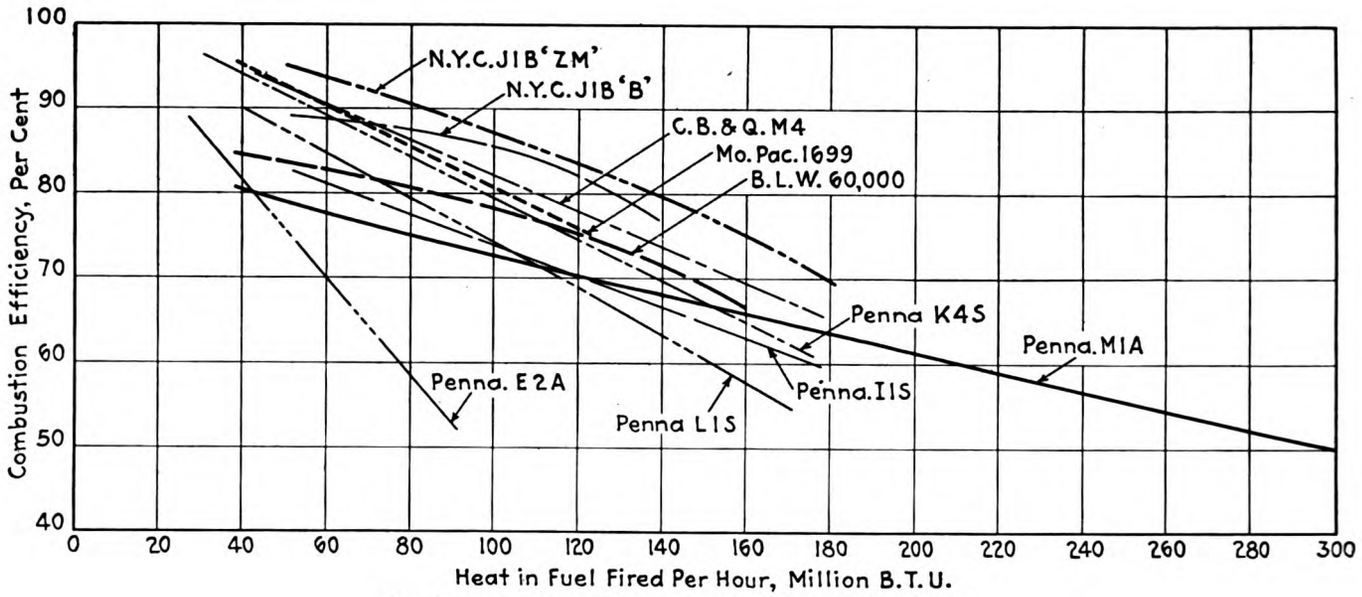


Fig. 5—Combustion efficiency versus heat in fuel fired per hour

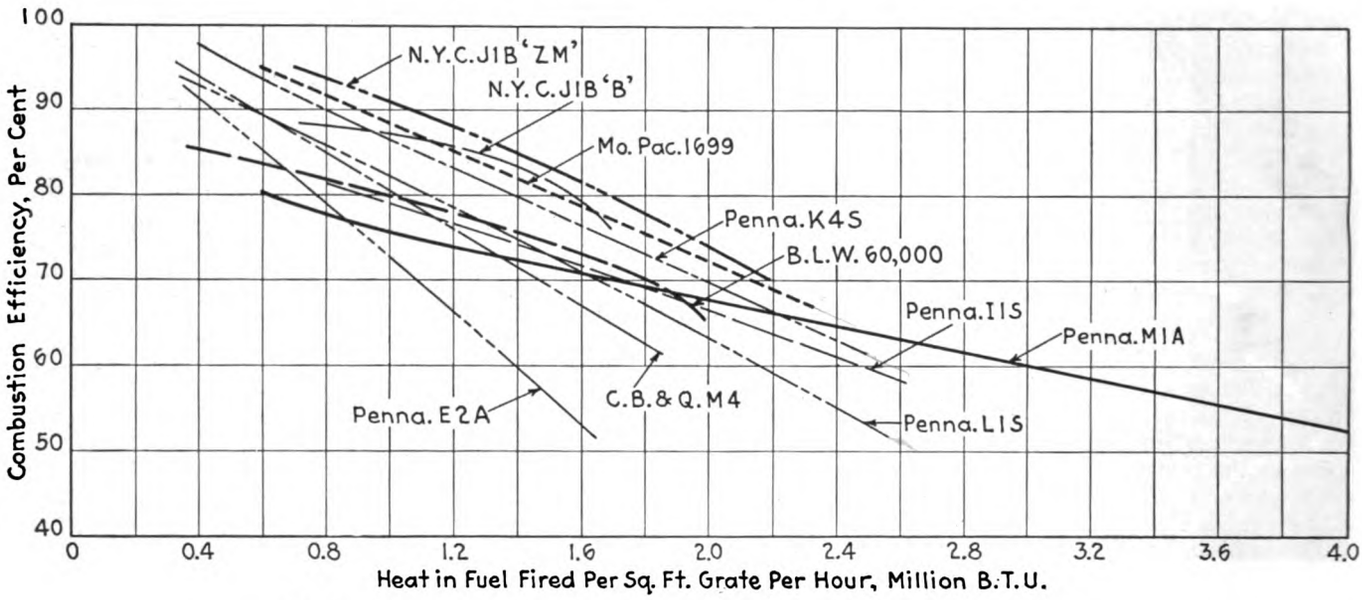


Fig. 6—Combustion efficiency versus heat in fuel fired per sq. ft. of grate per hour

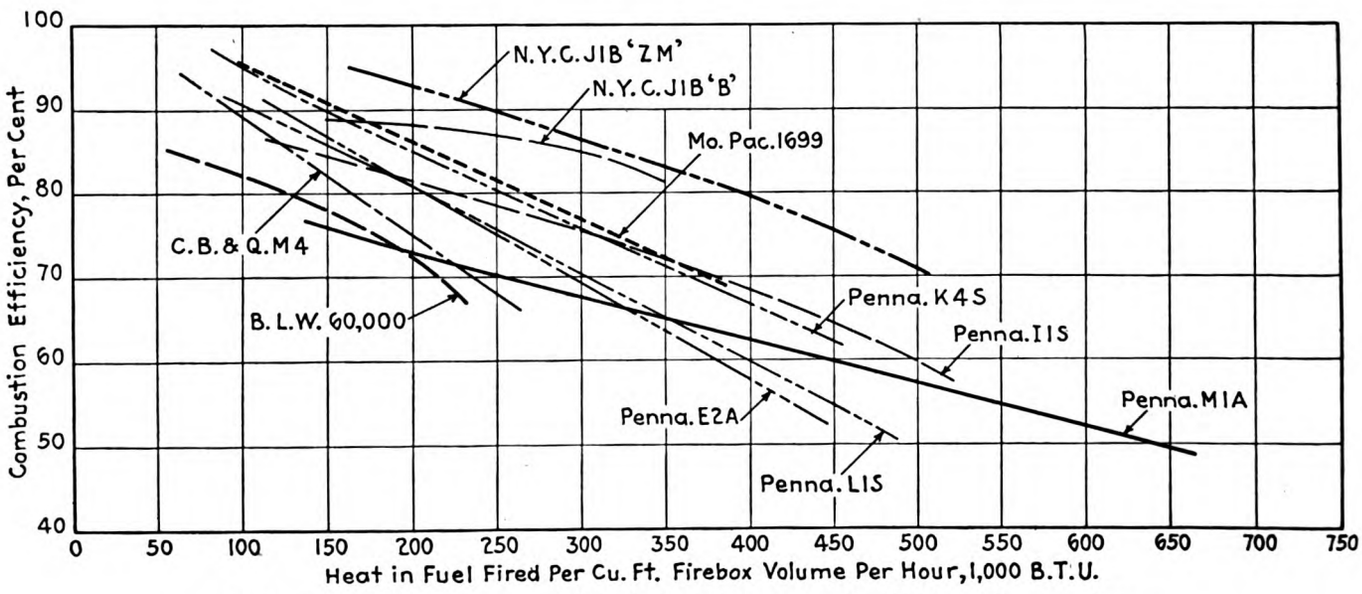


Fig. 7—Combustion efficiency versus heat in fuel fired per cu. ft. of firebox volume per hour

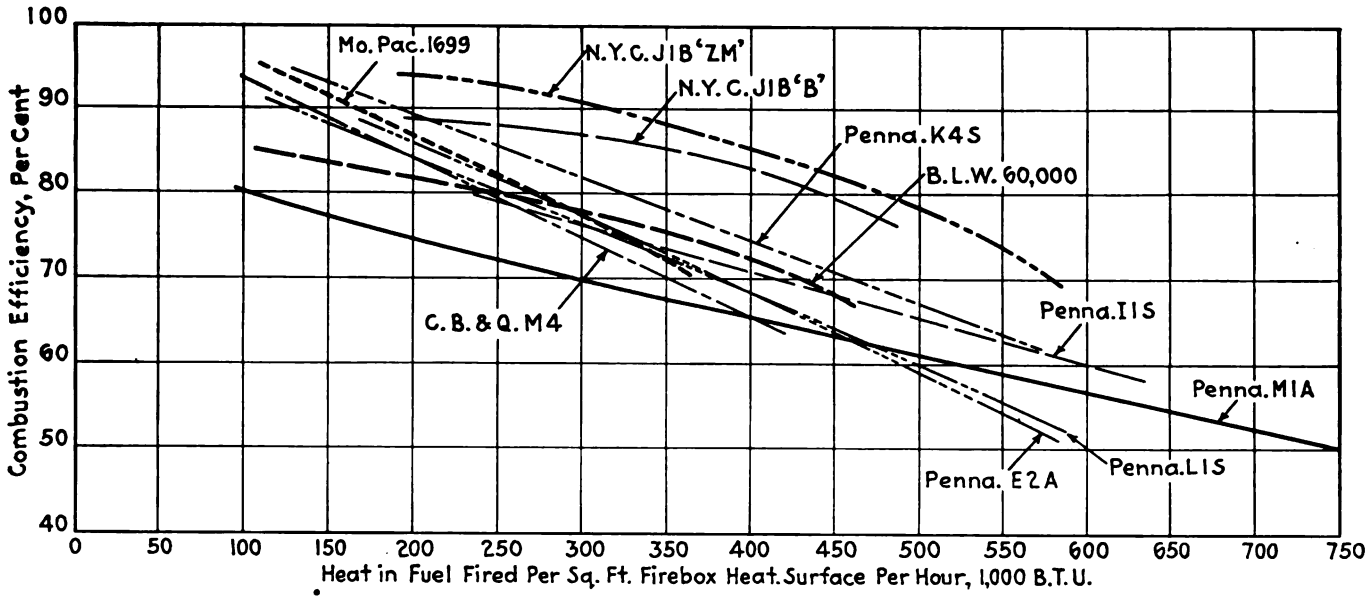


Fig. 8—Combustion efficiency versus heat in fuel fired per sq. ft. of firebox heating surface per hour

serious matter confronting locomotive designers today is the problem of improving the efficiency of combustion in the firebox, particularly at high-capacity operation. Incomplete combustion of fuel causes heavy losses in unburned fuel, high maintenance cost due to cinder cutting of firebox sheets, stay-bolt heads, tubes, and superheater. Damage due to fires along the right of way set by sparks, loss in good will to the general public due to smoke near railroad terminals, and loss of passenger traffic for the same cause constitute a serious challenge to designers and operators of steam locomotives.

Improvement in the combustion process of the locomotive furnace is a problem of primary importance and the proportions of the furnace should be such as not only to make possible complete combustion of the fuel with the elimination of smoke and cinders, but also to absorb sufficient radiant heat to control the furnace gases to a temperature low enough to prevent slagging at the flue sheet and on the superheater units. One would assume that sufficient data were available today to determine the correct volume of the firebox in relation to the grate area and heating surface. A study of Tables I to VI indicates, however, that there is little agreement on this subject; great variations exist in these basic ratios. To cite an example: The important ratio of firebox volume to grate area ranges from a minimum of 3.70 to a maximum of 8.28 cu. ft. per sq. ft. of grate area. Compared on the basis of tractive force the furnace volume varies from a minimum of 4.04 to a maximum of 11.67 cu. ft. per 1,000 lb. of tractive force.

The difference in opinion among locomotive designers as to the correct size of firebox and combustion chamber is due to the absence of pertinent facts and test data to permit a scientific evaluation of the various factors. It is known that the first cost of the heating surfaces in the firebox and combustion chamber is very high as is also the cost of the maintenance and inspection when compared with the tube heating surface. What the relative cost of firebox and tube maintenance amounts to is unknown. Little information is available as to the cost of boiler maintenance, since few American railroads keep accounts to permit such a study. In the report of the Federal Co-Ordinator of Transportation, November, 1935, the estimated average cost of boiler maintenance is given as 30 per cent of the total cost of locomotive repairs. The firebox maintenance is the greatest part of this cost. As a large modern boiler will have from 5,000 to 8,000 staybolts in the firebox which must be tested at regular intervals, the size of the firebox is a very important item when the question of intensive utilization of the locomotive is considered.

Against these items of cost should be balanced the great improvements in boiler efficiency and capacity which are generally believed to be obtained by the use of large fireboxes. The heat absorption of the firebox heating surfaces is from six to ten times as great as the average tube heating surface. Another important point not usually considered is that the radiant-heat absorption by the firebox is accomplished without the expenditure of any energy, while the heat absorption by convection in the tubes consumes considerable power to create the high draft required. The energy required to move the gases increases with the fourth power of the weight velocity. Only a few tests have been made which supply data permitting the calculation of combustion efficiency. These tests have been mainly on engines, the boiler ratios of which are very much alike, and thus the effect of greatly different boiler ratios is not clearly discernible from available data. To illustrate the effect which different boiler ratios have upon combustion efficiency, the data from all tests available have been plotted in Figs. 5 to 8.

It is, however, becoming more generally recognized that the larger the furnace volume of a locomotive, the greater is the opportunity for completing the processes of combustion. This is true only if the larger furnace volume is obtained in conjunction with maximum boiler diameter, furnace width and depth, and not by furnace length alone.

An examination of a typical boiler diagram, Fig. 2, shows the gas velocities at several points in the firebox, an explanation being given why the largest possible cross-sectional area through the firebox is very important. The velocity of the furnace gases in this case between the top of the arch and the crown sheet is as high as 260 m.p.h. It is remarkable that the small particles of coal being blown by the stoker jets into the center of a hurricane of such velocity are able to settle on the grate or have time to burn at all.

A particle of fine coal caught in the gas stream will

(Continued on page 64)

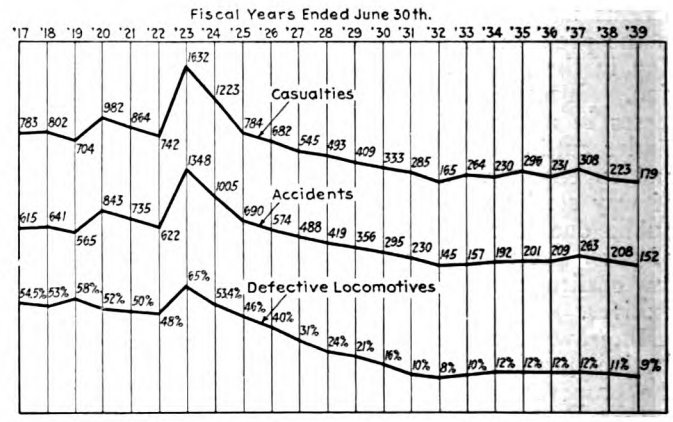
Locomotive Inspection Report

General improvement in the condition of both steam and other types of locomotives is indicated by the decreasing number of defective units found while, at the same time, the number of inspections increases

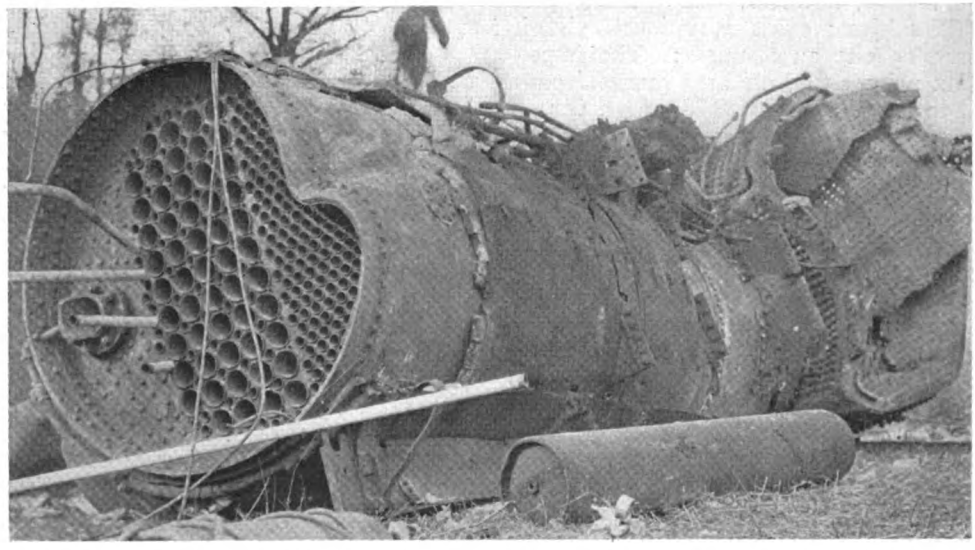
THE annual report of the Bureau of Locomotive Inspection, Interstate Commerce Commission, submitted by John M. Hall, chief inspector, covering the fiscal year ended June 30, 1939, shows an improvement in the condition of locomotives, both steam and other than steam. In the case of steam locomotives, there was a decrease of 1,432 in the number for which reports were filed; an increase of 420 in the number of locomotives inspected; a decrease of 1,951 in the number found defective; a decrease of 2 per cent in the number inspected and found defective; a decrease of 211 in the number ordered out of service, and a decrease of 8,724 in the total number of defects found. In the case of locomotives other than steam, the report shows increases in the number of locomotive units for which reports were filed and in the number inspected; decreases are shown for the number found defective, the total number of defects found and the percentage inspected and found defective.

The accompanying chart shows the percentage of defective locomotives, the number of accidents and the number of casualties for the fiscal years ended June 30, 1917, to 1939, inclusive. Summaries and tables included in the report show separately accidents and other data in connection with steam locomotives and tenders and their appurtenances and similar data covering locomotives other than steam.

During the fiscal year ended June 30, 1939, the number of steam locomotives for which reports were filed totaled 45,965. The number of steam locomotives inspected totaled 105,606 and 9,099, or 9 per cent, were found defective, and 468 were ordered out of service. In 1938 105,186 steam locomotives were inspected, of which 11,050, or 11 per cent, were found defective, and 679 ordered out of service. In the year ended June 30, 1937, a total of 100,033 steam locomotives were inspected, 12,402, or 12 per cent, were found defective, and 852 were ordered out of service. The total number of defects found and shown in the last three reports were: 33,490 in 1939, 42,214 in 1938, and 49,746 in 1937. In the case of locomotives other than steam, reports were filed covering 2,716 locomotives in the year ended June 30, 1939. The inspections made totaled 4,581, of which 260, or 6 per cent, were found defective, and 14 ordered out of service. The total number of defects found on this type of motive power in that year totaled 696. These figures compare with the following for the previous year



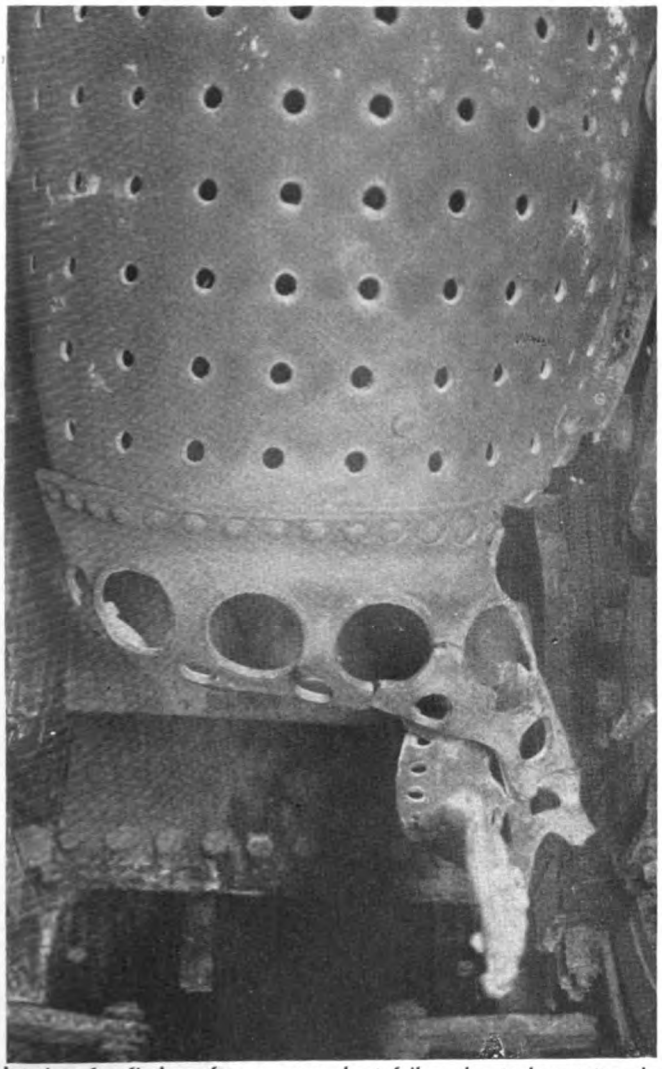
A 23-year record of accidents, casualties and defective locomotives



Result of an explosion caused by the overheating of the crown sheet due to low water—The boiler landed 318 ft. from the point where the explosion occurred and wreckage was scattered to distances up to 2,165 ft.—Two employees were killed

Table I—Number of Casualties Classified According to Occupation—Steam Locomotive Accidents

	Year ended June 30									
	1939		1938		1937		1936		1935	
	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured
Members of train crews:										
Engineers	4	46	3	70	8	106	4	75	7	65
Firemen	6	66	2	80	5	78	6	72	4	70
Brakemen	2	18	..	31	3	30	3	28	2	26
Conductors	..	5	..	6	1	18	..	13	..	10
Switchmen	..	6	..	7	..	10	..	2	..	3
Roundhouse and shop employees:										
Boilermakers	1	1	..	2	2	2	..	..	..	6
Machinists	..	2	..	..	..	2	..	4	1	3
Foremen	..	..	..	1	..	..	..	3	..	2
Inspectors	..	..	..	1	..	..	..	2	..	1
Watchmen	..	1	2	..	1	1	1	1	1	1
Boiler washers	..	..	..	1	..	..	..	..	..	..
Hostlers	..	1	..	6	..	9	..	3	..	3
Other roundhouse and shop employees	..	2	..	1	..	3	..	3	..	6
Other employees	..	2	..	3	1	14	..	5	14	49
Nonemployees	2	14	..	7	4	10	2	4	..	22
Total	15	164	7	216	25	283	16	215	29	267



Interior of a firebox after a crown sheet failure due to low water—In this accident, in which two employees were injured, the smokebox door and front were blown off and forced through the vestibule and partially through the door of an unoccupied sleeping car

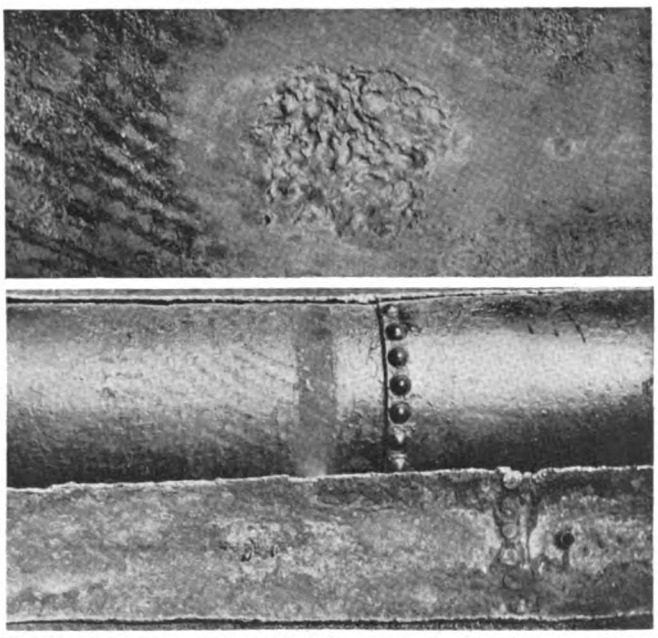
found on steam locomotives and gives the data on inspections and reports. Similar data for locomotives other than steam will be found in Table III.

Boiler Explosions

Six boiler explosions occurred during the past fiscal year and are commented on in the report. All of these explosions, in which 12 persons were killed and 11 were injured, were caused by the overheating of crown sheets due to low water.

Extension of Time for Removal of Flues

A total of 1,009 applications were filed for extensions of time for removal of flues, as provided in Rule 10. The



The top view shows the exterior of an air reservoir which was fusion welded where metal had deteriorated and wasted through along the bottom—The lower illustration shows the condition of the inside of the same reservoir along the bottom

ending June 30, 1938: Total number inspected, 4,024; number found defective, 274; percentage inspected and found defective, 7; number ordered out of service, 9; total number of defects found, 769.

Table I shows the number of casualties in connection with steam locomotive accidents classified according to occupation; Table II shows the nature of the defects

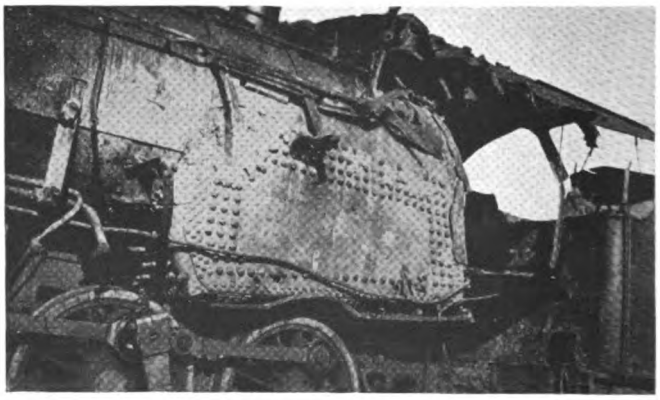
investigations of the bureau disclosed that in 64 of these cases the condition of the locomotives was such that extensions could not properly be granted. In the case of 31 locomotives, conditions were such that full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. Requests for 56 extensions were granted after defects disclosed by the

Table II—Number of Steam Locomotives Reported, Inspected, Found Defective, and Ordered from Service

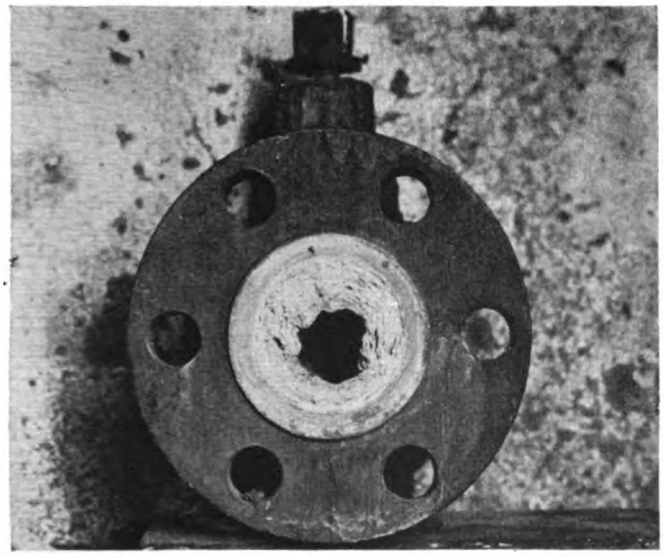
Parts defective, inoperative or missing, or in violation of rules	Year ended June 30— 1939	1938	1937	1936	1935	1934
1. Air compressors	518	689	766	740	733	660
2. Arch tubes	28	66	105	74	74	127
3. Ashpans and mechanism	67	72	80	79	94	87
4. Axles	2	13	10	13	10	6
5. Blow-off cocks	204	226	199	236	283	289
6. Boiler checks	279	301	382	356	413	407
7. Boiler shell	272	331	347	383	396	372
8. Brake equipment	1,577	2,044	2,322	2,480	2,449	2,326
9. Cabs, cab windows, and curtains	943	1,226	1,807	1,638	1,273	1,342
10. Cab aprons and decks	260	326	466	450	368	343
11. Cab cards	92	109	145	166	142	129
12. Coupling and uncoupling devices	60	73	74	65	73	54
13. Crossheads, guides, pistons, and piston rods	739	905	1,160	1,056	1,086	1,100
14. Crown bolts	47	59	76	63	75	77
15. Cylinders, saddles and steam chests	1,232	1,645	2,206	1,717	1,547	1,491
16. Cylinder cocks and rigging	418	585	729	605	627	654
17. Domes and dome caps	90	109	101	114	94	105
18. Draft gear	450	740	522	513	423	401
19. Draw gear	360	479	560	451	414	480
20. Driving boxes, shoes, wedges, pedestals and braces	1,330	1,688	1,637	1,712	1,573	1,472
21. Firebox sheets	238	244	371	295	343	356
22. Flues	165	159	225	178	173	203
23. Frames, tail pieces and braces, locomotive	708	1,001	1,053	997	1,006	951
24. Frames, tender	71	131	120	113	124	128
25. Gages and gage fittings, air	155	230	261	257	275	212
26. Gages and gage fittings, steam	226	279	324	350	320	289
27. Gage cocks	361	451	538	579	480	384
28. Grate shakers and fire doors	252	403	470	400	394	404
29. Handholds	349	405	510	502	464	377
30. Injectors, inoperative	26	26	38	40	39	33
31. Injectors and connections	1,457	1,784	2,020	2,085	2,035	1,909
32. Inspections and tests not made as required	6,645	8,204	9,638	9,005	8,344	8,173
33. Lateral motion	243	325	446	404	389	351
34. Lights, cab and classification	50	48	90	78	81	79
35. Lights, headlight	177	257	313	251	257	218
36. Lubricators and shields	200	212	254	255	191	215
37. Mud rings	248	203	272	237	241	247
38. Packing nuts	408	448	487	508	527	491
39. Packing, piston rod and valve stem	739	913	1,393	1,133	906	833
40. Pilots and pilot beams	104	154	133	178	152	174
41. Plugs and studs	179	238	238	236	167	242
42. Reversing gear	317	404	492	463	414	390
43. Rods, main and side, crank pins and collars	1,293	1,669	2,348	2,093	1,826	1,670
44. Safety valves	97	125	132	125	100	108
45. Sanders	432	536	655	678	779	697
46. Springs and spring rigging	2,340	2,901	3,172	3,008	2,765	2,854
47. Squirt hose	75	94	133	134	113	107
48. Stay bolts	181	211	276	279	240	285
49. Stay bolts, broken	258	380	542	520	512	455
50. Steam pipes	285	410	446	526	463	489
51. Steam valves	115	141	165	227	212	267
52. Steps	490	631	678	615	640	567
53. Tanks and tank valves	837	955	1,009	877	913	862
54. Telltale holes	58	67	79	127	102	93
55. Throttle and throttle rigging	638	685	909	760	733	639
56. Trucks, engine and trailing	628	762	785	861	811	898
57. Trucks, tender	665	907	1,018	1,108	1,120	918
58. Valve motion	554	722	798	824	799	784
59. Washout plugs	487	626	598	714	679	776
60. Train-control equipment	5	11	12	6	4	8
61. Water glasses, fittings and shields	690	915	1,049	1,118	951	907
62. Wheels	466	577	803	790	697	734
63. Miscellaneous—Signal appliances, badge plates, brakes (hand)	610	684	759	608	563	572
Total number of defects	33,490	42,214	49,746	47,453	44,491	43,271
Locomotives reported	45,965	47,397	48,025	49,322	51,283	54,283
Locomotives inspected	105,606	105,186	100,033	97,329	94,151	89,716
Locomotives defective	9,099	11,050	12,402	11,526	11,071	10,713
Percentage of inspected found defective	9	11	12	12	12	12
Locomotives ordered out of service	468	679	934	852	921	754

Table III—Number of Locomotives Other Than Steam Reported, Inspected, Found Defective and Ordered from Service

Parts defective, inoperative or missing, or in violation of rules	Year ended June 30— 1939	1938	1937	1936	1935	1934
Air compressors	14	6	6	2	5	3
Axles, truck and driving	1	5	4	6	1	..
Batteries	1	1	4	..	7	..
Boilers	6	6	5	5	3	1
Brake equipment	50	74	97	66	46	15
Cabs and cab windows	36	25	51	30	33	9
Cab cards	18	11	25	..	..	..
Cab floors, aprons, and deck plates	13	8	17	10	6	1
Controllers, relays, circuit breakers, magnet valves, and switch groups	13	7	8	..	..	5
Coupling and uncoupling devices	4	4	3	..	..	..
Current-collecting apparatus	5	8	4	16	3	3
Draft gear	17	23	28	24	21	8
Draw gear	4	3	1	1	..	..
Driving boxes, shoes and wedges	52	16	14	5	5	7
Frames or frame braces	9	37	5	15	4	6
Fuel system	35	47	152	44	15	4
Gages or fittings, air	6	11	1	6	4	..
Gears and pinions	2	2	2	..	..	1
Handholds	8	13	11	8	3	..
Inspections or tests not made as required	185	204	237	186	124	52
Insulation and safety devices	4	13	13	20	15	2
Internal-combustion engine defects, parts and appliances	32	26	50	23	4	4
Jack shafts	6	1	..	1	..	..
Jumpers and cable connectors	1	1	2	..	..	..
Lateral motion, wheels	1	..	1	2	..	3
Lights, cab and classification	3	2	5	6	1	..
Lights, headlight	4	4	11	4	2	..
Meters, volt and ampere	2	2	1	2	..	..
Motors and generators	19	18	10	14	5	4
Pilots and pilot beams	6	1	7	6	5	..
Plugs and studs	..	..	1	..	..	..
Quills	7	6	3	..	..	..
Rods, main, side, and drive shafts	2	2	23	2	10	4
Sanders	28	37	52	25	21	2
Springs and spring rigging, driving and truck	16	43	36	29	20	4
Steam pipes	..	5	1	2	..	..
Steps, footboards, etc.	18	23	13	..	..	..
Switches, hand-operated, and fuses	5	7	2	2	2	1
Transformers, resistors, and rheostats	1	3	..	..	1	1
Trucks	33	40	41	42	46	3
Water tanks	1	..	1	..	..	..
Water glasses, fittings, and shields	1	3	..	4	6	..
Warning signal appliances	1	3	2	1	..	..
Wheels	16	11	21	26	6	8
Miscellaneous	10	7	20	39	25	7
Total defects	696	769	991	674	449	158
Locomotive units reported	2,716	2,555	2,416	2,361	1,911	1,288
Locomotive units inspected	4,581	4,024	3,615	3,118	1,620	1,436
Locomotive units defective	260	274	328	252	146	69
Percentage inspected found defective	6	7	9	8	9	5
Locomotive units ordered out of service	14	9	24	11	5	4



The results of a broken crosshead arm when the locomotive was moving at an estimated speed of 40 m. p. h.





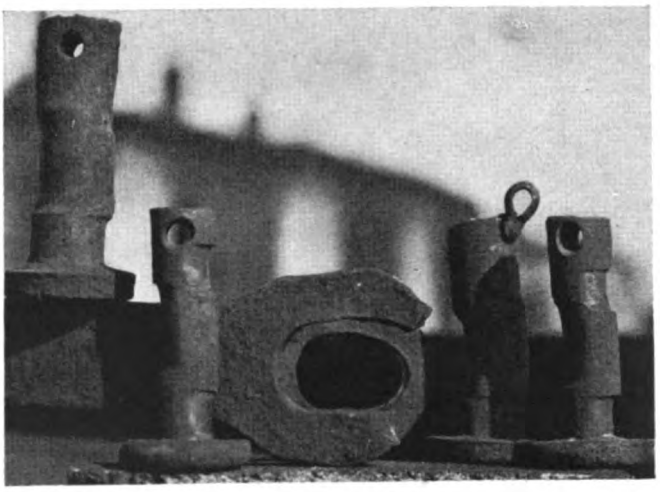
Two cases of scale accumulation—In the boiler check (above) the diameter of the opening was reduced from 2½ in. to 1 in. causing erratic operation of the injector—The lower illustration shows a water column practically closed by hard scale

bureau's investigations were repaired. Fifteen applications were cancelled for various reasons. Extensions for the full time requested were granted in 843 cases.

Locomotives Propelled by Power Other Than Steam

There was an increase of one in the number of accidents occurring in connection with locomotives other than steam and an increase of one in the number of persons injured as compared with the previous year. No deaths occurred in either year.

During the year 6 per cent of the locomotives inspected



The condition of a driving-brake pull rod and pins on a locomotive withheld from service by a Bureau inspector—The report of a monthly inspection by the railroad, two days previous to the Bureau's inspection, showed the condition of the brake equipment as "good"

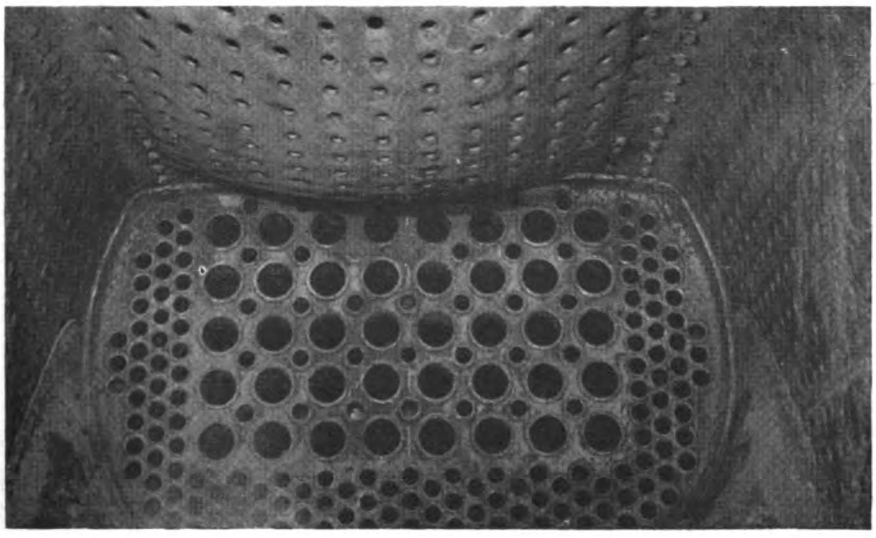
were found with defects or errors in inspection that should have been corrected before the locomotives were put into use as compared with 7 per cent in the previous year. There was an increase of 5 in the number of locomotives ordered withheld from service by the inspectors, because of the presence of defects that rendered the locomotives immediately unsafe.

Specification Cards and Alteration Reports

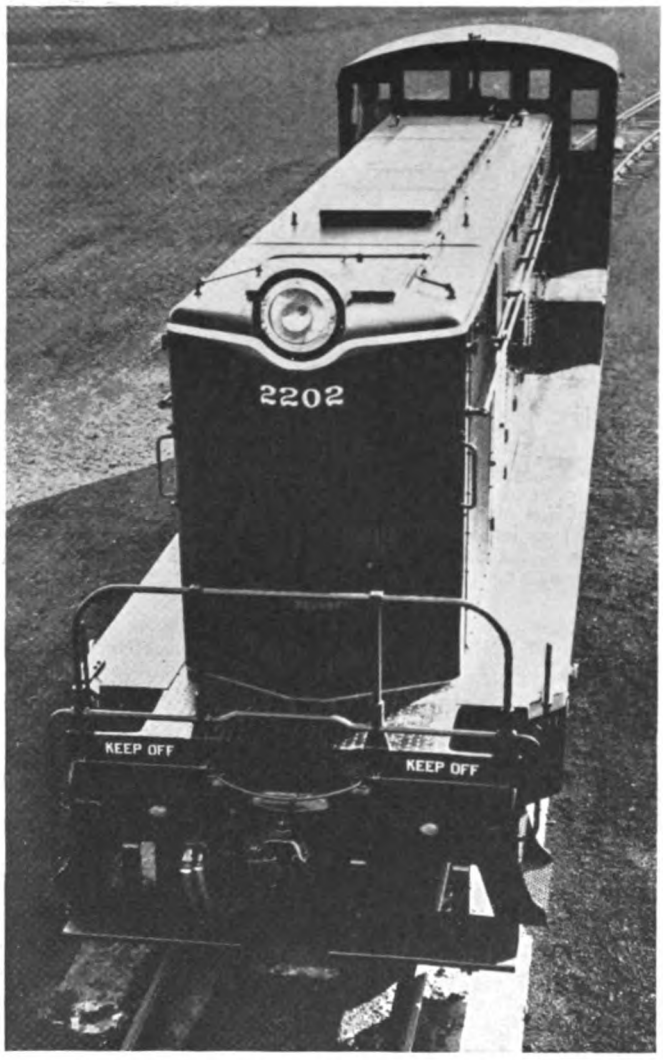
Under Rule 54, of the Rules and Instructions for Inspection and Testing of Steam Locomotives, 131 specification cards and 4,493 alteration reports were filed, checked, and analyzed. Corrective measures were taken with respect to numerous discrepancies found as a result of checking these reports.

Under Rules 328 and 329 of the Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam, 252 specifications and 90 alteration reports were filed for locomotive units and 60 specifications and 36 alteration reports were filed for boilers mounted on locomotives other than steam. These were checked and analyzed and corrective measures taken with respect to discrepancies found.

No formal appeal by any carrier was taken from the decisions of any inspector during the year.



This crown sheet failure resulted in the death of two employees



Baldwin Diesel–Electric Switchers

Stock locomotives built at the Eddystone plant are powered with eight- and six-cylinder, 1,000- and 660-hp. De La Vergne Diesel engines and Westinghouse electric generating, traction and control equipment

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THE first of a group of 28 Diesel-electric switching locomotives of 1,000 and 660 hp. to be built in line production at the Eddystone (Pa.) plant of the Baldwin Locomotive Works, have recently been completed and five of the 1,000 hp. type were delivered to the Atchison, Topeka & Santa Fe.

Each locomotive is powered with a single De La Vergne, Model VO, Diesel engine of eight or six cylinders, respectively, and Westinghouse generating, control and traction equipment. The eight-cylinder, 1,000-hp. locomotive weighs 120 tons, while the six-cylinder, 660-hp. unit weighs 100 tons. The comparative specifications are shown in the table.

The 660-hp. locomotive has a continuous rating of 28,000 lb. tractive force at 6.5 m.p.h. and the 1,000-hp. unit a continuous rating of 33,600 lb. tractive force at 8.3 m.p.h. A tractive force above 33,600 lb. can be developed by the 1,000 hp. locomotive (above 28,000 lb. by the 660-hp. locomotive) for shorter periods, depending upon the initial temperature of the traction motors.

Cooperative Specifications of Baldwin 120-Ton, 1,000 hp. and 100-Ton, 660-hp. Diesel-Electric Switching Locomotive

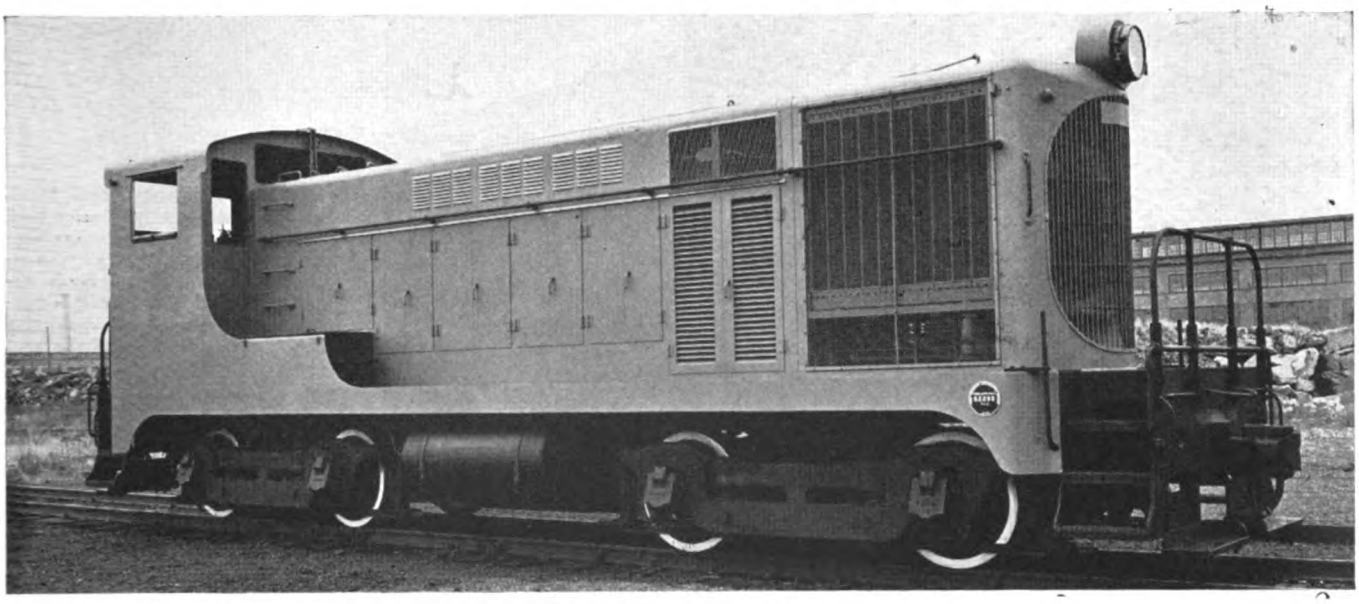
	1,000 hp.	660 hp.
Total b.hp. (single Diesel engine)	1,000	660
Engine, no. of cylinders	8	6
Total weight of locomotive, in working order, approx., lb.	240,000	200,000
Length over couplers, ft.-in.	48- 0	45- 0
Wheelbase of locomotive (total), ft.-in.	33- 6	30- 6
Wheelbase of truck (rigid), ft.-in.	8- 0	8- 0
Height from rail to top of cab (maximum), ft.-in.	14- 6	14- 6
Height from rail to centerline of couplers, in..	34	34
Height from rail to cab floor, ft.-in	7- 3	7- 3
Height from rail to top of engine compartment hoods, ft.-in.	12- 3⅛	12- 3⅛
Width (maximum outside), ft.-in.	10- 0	10- 0
Width of cab, ft.-in.	9-10	9-10
Width of engine compartment hoods (outside), ft.-in.	5- 8¼	5- 8¼
Fuel oil capacity, gals.	700	600
Water capacity, gals.	320	240
Lubricating oil capacity, gals.	64	55
Sand capacity, lb.	3,000	3,000
Driving wheels, diameter, in.	40	40
Journal load, lb.	26,400	21,400
Starting tractive force, 30 per cent adhesion, lb.	72,000	60,000
Starting tractive force, 25 per cent adhesion, lb.	60,000	50,000
Maximum speed, m.p.h.	60	45

The De La Vergne Engines

The De La Vergne Model VO Diesel engines operate on the four-cycle principle, using solid injection. The six-cylinder engine is rated at 660 hp. and the eight-cylinder engine 1,000 hp. at 625 r.p.m. Both engines have 12¾ in. by 15½ in. cylinders. Accessibility is obtained by mounting the governor, lubricating-oil pump, fuel-transfer and injection pumps, fuel lines, spray valves and camshaft externally; working parts are enclosed.

A feature of the De La Vergne engine is the spherical water-cooled combustion chamber which is cast integrally with the cylinder head, and connected with the cylinder combustion space by a throat. During the compression stroke the air is forced into the chamber, entering tangentially at high velocity, thereby producing great turbulence. Fuel oil is sprayed into the combustion chamber through a multiple-orifice spray nozzle which has comparatively large openings. This feature, together with the cooling of the nozzle, minimizes clogging. The De La Vergne combustion system permits the injection of fuel over a longer period, at an unusually low injection pressure, resulting in lower firing pressure rise per degree of crank travel, and low maximum combustion pressures.

The fuel injection system is the Bosch solid-injection



The Baldwin 100-ton switcher, powered by a 660-hp. De La Vergne engine

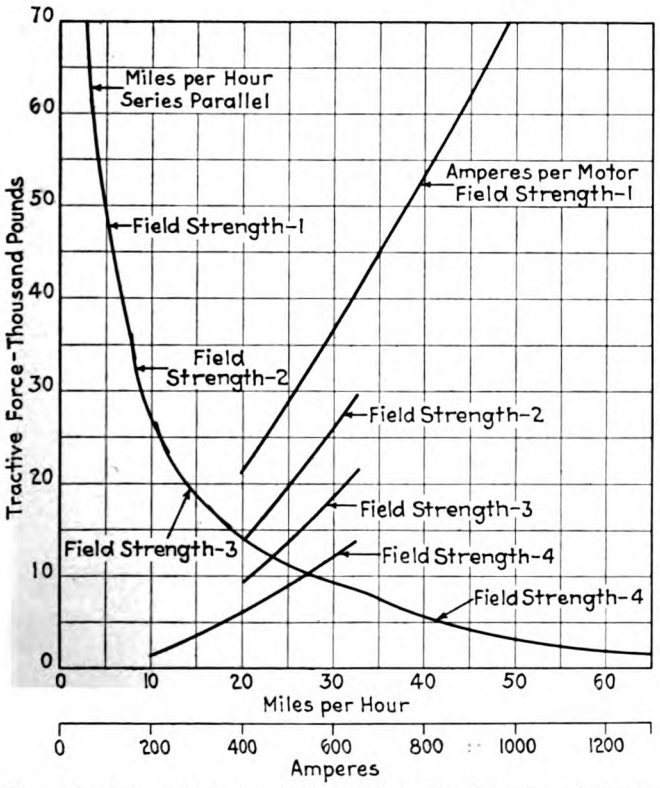
type with spring-loaded needle-type spray valves and multi-hole nozzles. One Bosch fuel injection pump and one spray valve are provided for each cylinder.

The fuel supply is delivered to the injection pumps by a positive-displacement fuel service pump. This pump delivers fuel under pressure through metal-edge strainers and a cartridge-type filter, in series, to the injection-pump supply header. Fuel oil pressure in the supply header is controlled by a spring-loaded relief valve.

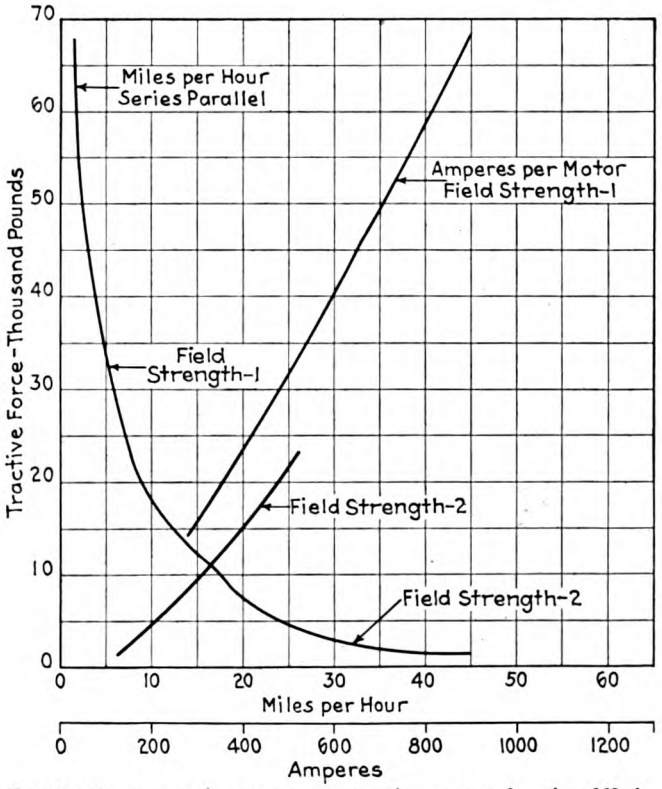
The engine bedplate is made of welded steel with heavy transverse webs to support the main bearings and to maintain proper crankshaft alignment. The main bearing caps are secured to the bedplate by internal throughbolts. The frame is a welded steel structure which forms the cylinder housing and upper part of the crankcase.

The main bearings consist of interchangeable steel shells with centrifugally poured babbitt. All main bearings are adjustable by means of laminated shims. The lower shell may be rolled out with the crankshaft in place. The cylinder liners are of a stress-relieved iron. They are machined all over, and finished internally by honing. Each liner has a flange at the top which seats in the engine frame, and is provided with rubber rings at the lower end to seal the joint between the liner and the frame.

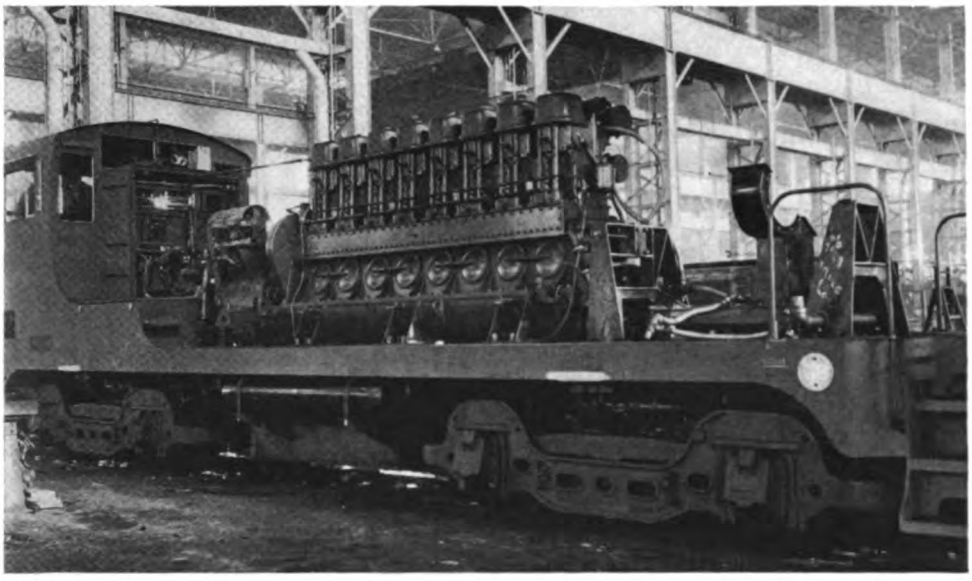
The cylinder heads are stress-relieved iron castings. The turbulence combustion chamber is located in the cyl-



Curve showing current consumption and tractive force in relation to speed for the 1,000 hp. locomotive—The gear ratio is 16 to 59



Tractive force—speed—current consumption curves for the 660 hp. Diesel-electric locomotive with a gear ratio of 16 to 76



One of the eight-cylinder, 1,000-hp. switchers partially assembled. The control panel compartment can be seen ahead of the cab; the air compressor is located between the generator and the control panel; the radiators and air circulating fans at the forward end of the locomotive have not yet been mounted

inder head, offset from the cylinder center, and is surrounded by cooling water. This arrangement permits the placing of the spray valve horizontally at the side of the head, in an accessible position, and provides cooling for the spray valve.

One exhaust and one inlet valve is arranged in the head for each cylinder. They are actuated by rocker arms mounted on brackets attached to the cylinder head. The rocker arms are fitted with rollers to contact the valve stems and are actuated by hollow push rods, socket-mounted in roller-type cam followers. The camshaft is located in a housing on the control side of the engine. The camshaft bearings are removable.

The crankshaft is a solid forging of heat-treated, open-hearth steel, drilled for pressure lubrication.

The connecting rods are made of die-forged alloy steel, heat-treated. The wrist-pin end is fitted with a one-piece bushing of high-grade bearing bronze. The crank-pin bearings have centrifugally cast, babbitt-lined steel-backed shells, fitted with laminated shims. Two heat-treated alloy-steel crank-pin-bearing bolts are used for each rod.

The hollow bored wristpins are of the full floating type, made of alloy steel forgings.

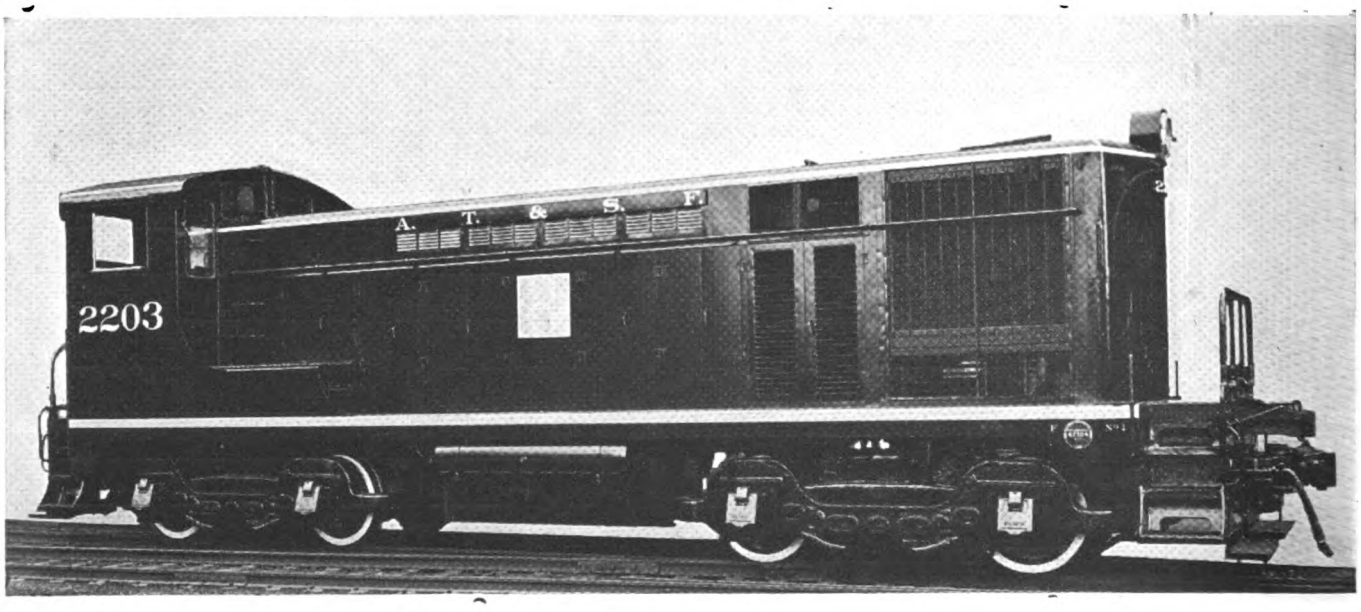
The pistons are made of aluminum alloy. Each piston carries five compression rings and has one lubricating oil control ring above the wristpin and one below.

The Woodward governor is gear-driven from the camshaft. It is of the hydraulic relay type and its speed setting is determined by an electro-pneumatic governor operator.

Lubrication is furnished by a pressure system to the crankshaft, connecting rods, wrist-pin bearings, cylinder liners, camshaft bearings and valve rocker arms. An automatic lubricating-oil safety stop is applied to shut off the fuel supply to the injection pumps in the event that the lubricating-oil pressure should drop below a safe minimum.

Electrical Transmission

The engine is directly coupled to a Westinghouse generator which supplies power to four axle-hung force-ventilated series-wound Westinghouse traction motors. The generator for the 660-hp. locomotive has a continuous rating of 1,000 amp., while that for the 1,000-hp. locomotive is rated 1,200 amp. Exciters are mounted on the generator shafts.



Baldwin 120-ton, 1,000-hp. switcher built for the Santa Fe

The continuous ratings of the motors are 470 and 560 amp. when blown with 1,100 and 1,200 cu. ft. of air per minute, respectively. Two blowers supply cooling air for the traction motors. They are mounted at opposite ends of the engine-generator-compressor unit and are driven by V belts taking power from the main shaft.

Electro-pneumatic control is used to operate two motors in series, two in parallel, full field, and two motors in series and two in parallel, shunted field. The engine governor is electro-pneumatically controlled from the master controller. Excitation of the main generator is automatically controlled to utilize the full output of the engine over its operating range, and avoid overloading.

An auxiliary generator furnishes power for charging the battery, and for the operation of control circuits and lights. It is mounted on top of the exciter frame and is driven from the generator shaft by grooved pulleys and V-belts.

The storage battery on the stock locomotives consists of 56 cells of Philco 17-XV on the 1,000-hp. unit and 56 cells of Philco 21-KRT on the 660-hp. These are rated at 288 and 240 amp.-hr. respectively. The five Santa Fe 1,000 hp. locomotives were equipped with Exide 56-cell, 288 amp.-hr. batteries. The batteries are used for engine starting and standby lighting and are charged from the auxiliary generator.

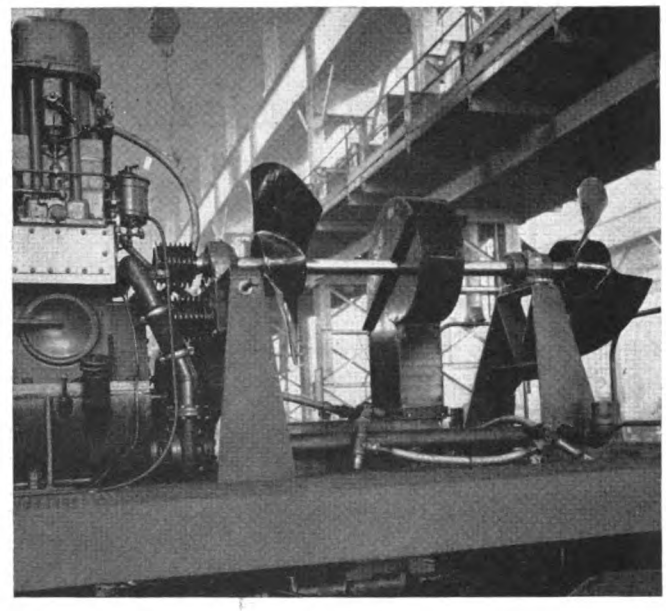
Other Construction Features

The underframes for both the 660- and 1,000-hp. locomotives are cast steel, manufactured by the General Steel Castings Corporation. The cab is located at one end of the locomotive. Directly ahead of the cab, under the hood, is the electrical control panel, then the compressor, the generator and engine unit and, at the other end of the locomotive, the blower, fans and radiators.

The cab is built of steel plates, with wood floor, and lined with Masonite insulating board. The cab doors are steel, and the windows extruded aluminum shapes. All windows are glazed with Saftee glass. The side windows are of the sliding type and have locating latches. The operator's control station is at the right-hand side of the cab. The operator has direct clear vision over and alongside the hood. Three pneumatic window wipers are part of the cab equipment.

The engine radiator compartment is located at the front end of the locomotive. Two fans, driven by V-belt from the engine shaft, draw air into a chamber and blow it out through the two radiators located at either side. On the same shaft is the blower for the traction motors on the front truck. Adjustable radiator shutters permit engine operation at correct temperatures.

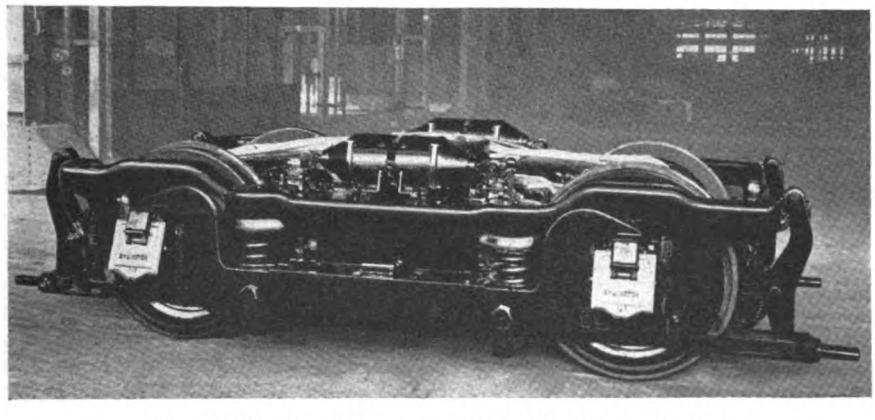
The fuel tank for the 1,000-hp. locomotive has a total capacity of 700 gal., that of the 660-hp. locomotive, 600 gal. Both are made of welded steel plates. They are mounted crosswise under the main frames between the trucks. The tank has a filler cap to permit filling from either side of the locomotive, and four sight gages, two located on each side. The electrically-driven gear-type fuel-oil transfer pump takes its suction directly from the fuel tank.



The air circulating fans, before the installation of the radiators

The trucks for stock locomotives are the General Steel Castings four-wheel type. The frames are cast steel with pedestal jaws and center plates cast integral. Double helical and semi-elliptic springs support the truck frame. The semi-elliptic springs are swung on forged links held by two equalizers on each side of the truck. The equalizer ends rest in seats on the journal boxes. Hollow transoms conduct the air from the blowers to the traction motors. The Santa Fe 1,000 hp. locomotive shown in one illustration is equipped with trucks of Baldwin design. The motors are supported between the driving axles and the spring motor-nose suspension on the truck transoms. The axle journals are 6½ in. by 12 in. The axle diameter through the motor bearing is 8¼ in. diameter. The rolled-steel wheels are 40 in. in diameter. The journal boxes are cast steel with forged-steel wedges and A.A.R. railway type crown brasses. A thrust bearing is provided in each box for absorbing the lateral thrust of the axle. The side bearings are hardened steel

(*Continued on page 64*)



Four-wheel truck of the type used on the stock locomotives

Comparative Service Tests of

USS Cor-Ten Vs. Copper Steel

Report of service life of hopper cars in coke-carrying service built with copper steel in one end and USS Man-Ten or USS Cor-Ten in the other end

When USS Cor-Ten was introduced for railroad car construction, the results of atmospheric corrosion tests were available which showed the resistance of this material to corrosion in various types of atmospheres to be four to six times that of carbon car steel, or two to three times as much as copper steel. This superior corrosion resistance was due partly to the fact that the rust which formed on USS Cor-Ten was harder than that on carbon steel or copper steel and that it adhered more tenaciously to the base metal. In view of the differences between the conditions in an atmospheric test and those existing in open-top freight cars, the question arose whether the abrasive action of the lading, especially in hopper cars, would remove the coating from Cor-Ten and cause rusting to proceed in cars more nearly at the same rate as with copper steel.

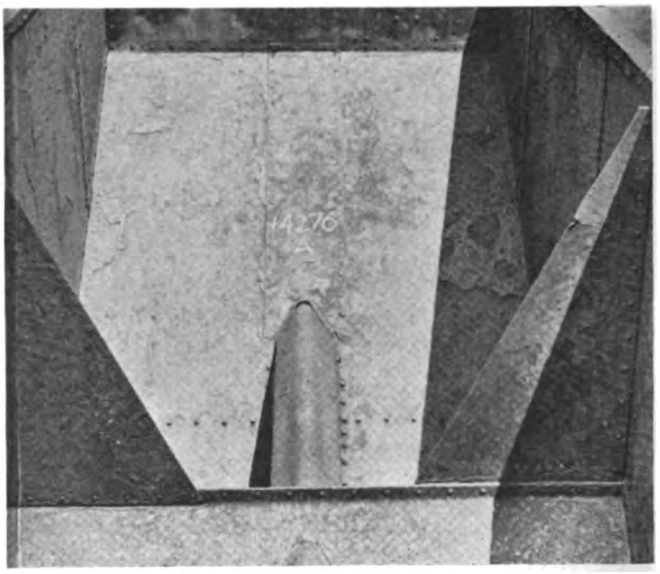
As this question seemed to have an important bearing on the advantage to be derived from the use of USS Cor-Ten in open-top cars, the rate of rusting of cars resulting from abrasion and the action of corrosive leachings from coal was studied by the Corrosion Research Laboratory of the Carnegie-Illinois Steel Corporation. The results of this investigation indicated that the corrosion of steel cars was caused principally by exposure to atmospheric conditions and that longer service life would be obtained by using a steel such as Cor-Ten which is much more resistant to severe industrial atmospheres than plain or copper steel.*

In order to obtain results from actual service as quickly as possible some 50-ton hopper cars owned by the Carnegie-Illinois Steel Corporation were repaired in 1934, using one type of steel in the *A* end of the car and another type in the *B* end. The materials applied for the test included Cor-Ten, an intermediate manganese steel, and copper steel. Where copper steel was used, the floors, hoppers, longitudinal hoods, and cross hoods were all ¼ in. thick, and the sides and ends 3/16 in. thick. The high-tensile steels were applied to some cars in these same thicknesses and in other cars the bottoms were made 3/16 in. thick and the sides and ends ⅛ in.

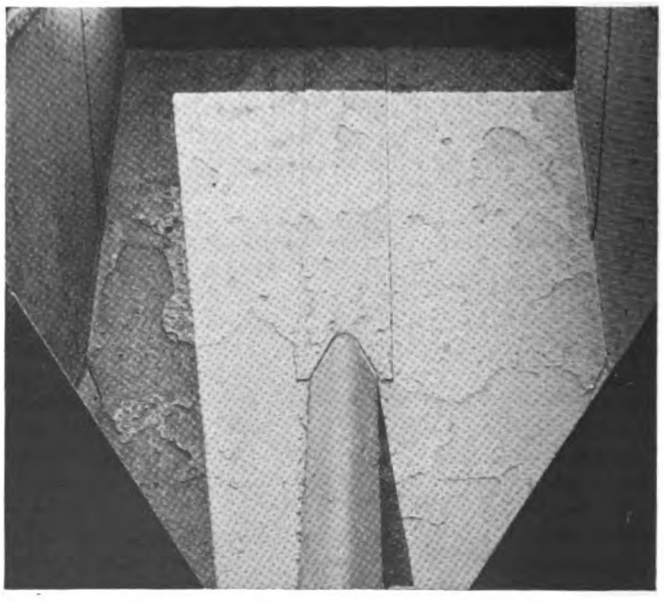
All of the test cars were placed in service in November, 1934. Some have been in coal service, but the majority have been handling furnace coke between the Clairton By-Product Coke Works and Carrie Furnaces, making frequent trips of 6.6 miles loaded with coke and returning empty. The cars have had intensive use and carried an average of 567 loads up to July 1, 1939, or 10.2 loads per month.

Since the end of the first year's service the cars have been inspected thoroughly at intervals of about six months. As the principal object of the test was to determine the ultimate life of the material, these inspections have consisted of noting the condition of the bodies and especially any perforations in the sheets, and the extent to which the sheets were corroded and worn away. When the test is completed, the loss of weight of each part will be determined.

The condition of the cars now gives definite indications of the relative life to be expected from the materials tested in coke cars and also in other service. Perforations have developed in a large majority of the longi-



Car No. 14276—The copper-steel sheets in the A end were found perforated after 30 months' service

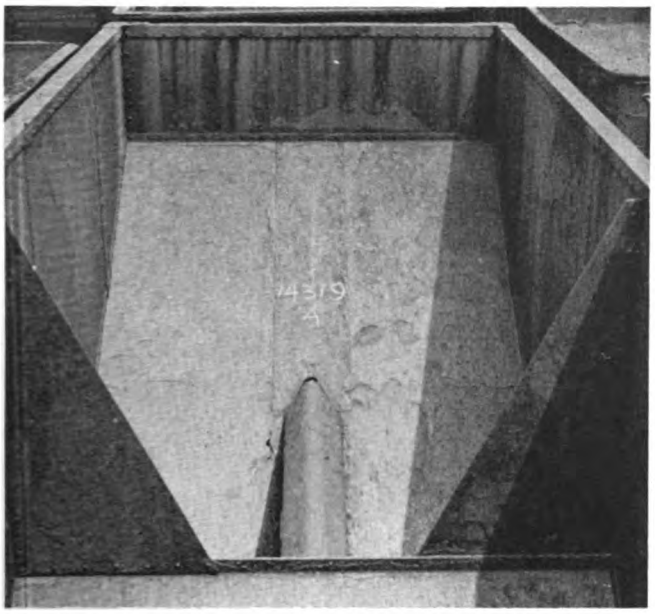


Car No. 14276—The USS Cor-Ten sheets in the B end showed no defects after 57 months' service

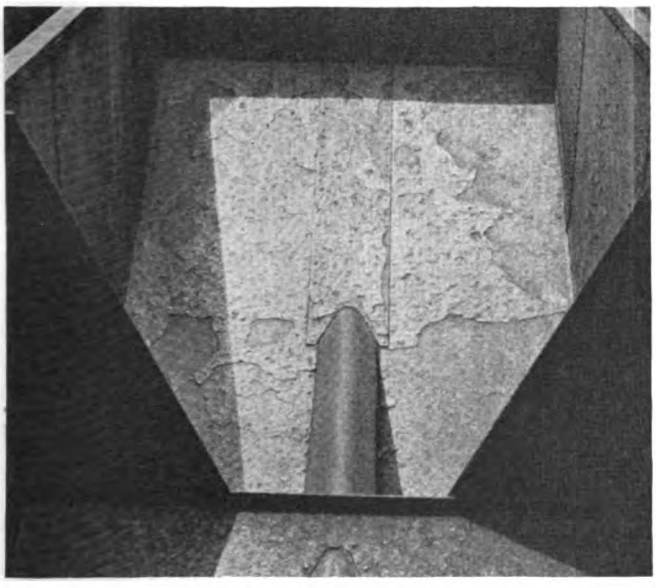
* See "Corrosion of Steel Cars," by G. N. Schramm, E. S. Taylerson and C. P. Larrabee, Railway Age, November 28, 1936, page 780.

tudinal hoods, hopper sheets, and floors. In some cars such failures have occurred in all three of these parts. The sides and ends have shown no failures up to this time.

Of the five cars with ¼-in. copper-steel floors, three were found perforated after 30 months' service and two after 42 months' service. The ¼-in. floors of intermediate manganese steel were perforated in the same period, but the general condition of the sheets was better than the copper steel. Three cars with ¼-in. Cor-Ten floors show no defects after 57 months, indicating that in coke service Cor-Ten will last twice as long as copper steel of equal thickness.

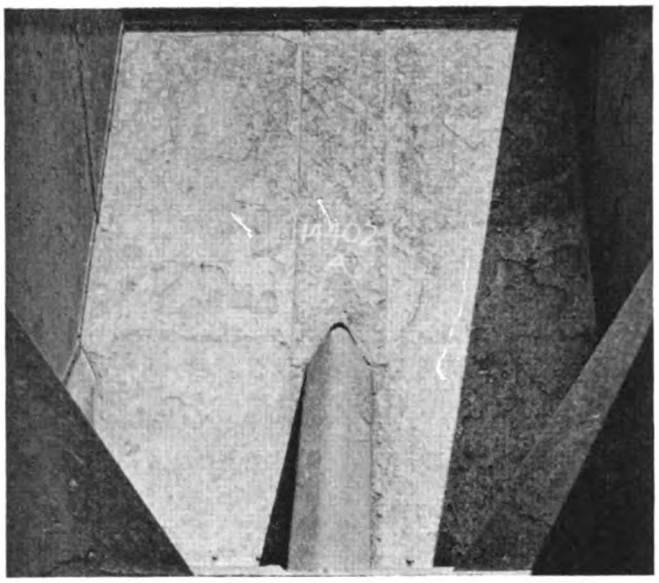


Car No. 14319—Copper-steel sheets in the A end were found perforated after 42 months' service

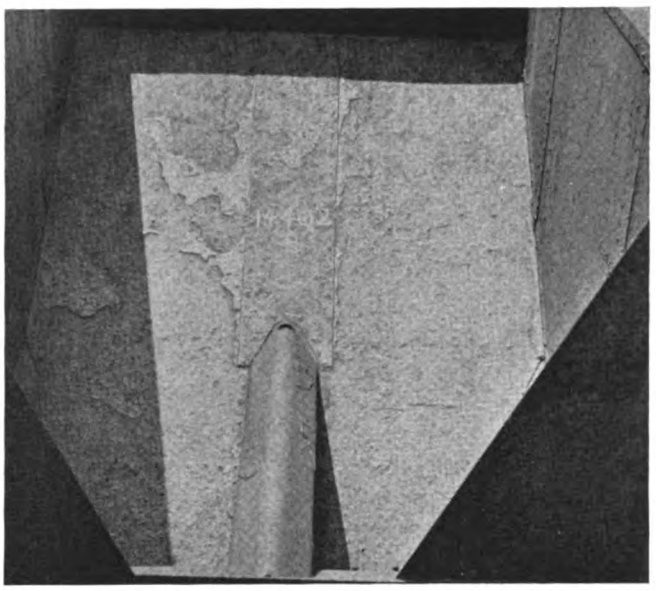


Car No. 14319—The USS Cor-Ten sheets in the B end showed no defects after 57 months' service

Of the two cars with 3/16-in. Cor-Ten floors and hoppers, one showed the first perforation after 42 months and the other was intact after 57 months. On the basis of comparing the relative life of copper and Cor-Ten steels after the first perforation the Cor-Ten steel, in



Car No. 14402—The copper-steel sheets in the A end were found perforated after 30 months' service



Car No. 14402—The USS Man-Ten sheets in the B end were perforated after 30 months' service

25 per cent thinner gage than copper steel, still gave 40 per cent longer life.

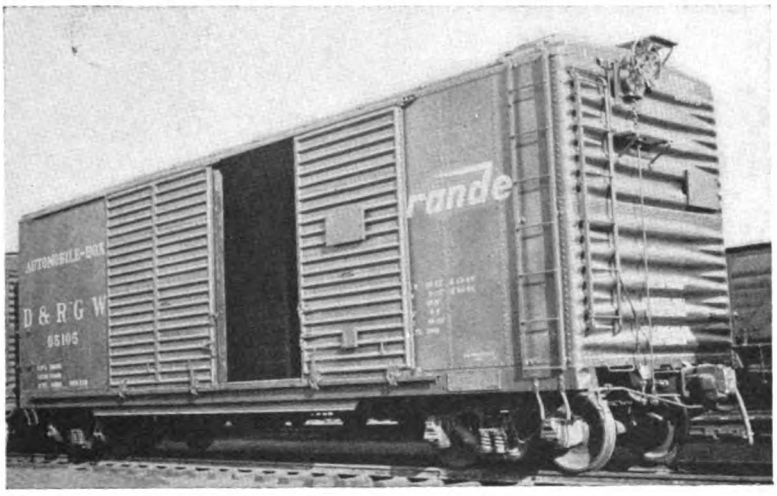
The performance of the intermediate manganese steel in this test brings out some significant facts. This steel has approximately the same strength and abrasion resistance as Cor-Ten. In resistance to atmospheric corrosion, intermediate manganese steel is equal to copper steel. Even though the abrasive action of coke on the floors of these cars is severe, the copper steel lasted almost as long as the intermediate manganese steel. The results indicate definitely that the life of the floor sheets in these hopper cars is affected only to a minor degree by variations in strength or abrasion resistance of the steels tested. On the other hand, Cor-Ten, which, in addition to higher strength and abrasive resistance, has superior resistance to atmospheric corrosion, gave increased life over the other steels almost in the same ratio as the increase noted in atmospheric corrosion tests.

Among the diversified conditions to which steels are subjected in car service, these coke hopper-car floors,

(*Continued on page 64*)

Denver and Rio Grande Western

Automobile-Box Cars



These cars have an unusual door arrangement which facilitates their use in either the transportation of automobiles or grain and other box-car commodities



Above: The large door closed and the standard 6-ft. box-car door open, ready for the loading of box-car commodities—Right: The clear opening is 15 ft. 1 in. wide when both doors are open for the loading of automobiles

ONE hundred automobile-box cars of 50 tons capacity were recently delivered to the Denver and Rio Grande Western by the Pressed Steel Car Company. The cars are of lightweight construction and embody a new door arrangement which utilizes an auxiliary inside door, patented by W. H. Sagstetter, chief mechanical officer, Denver and Rio Grande Western.

The cars have two doors on each side of different widths which enables the door openings to be made 15 ft. wide by 10 ft. ¾ in. high for the loading of automobiles, or with a standard 6-ft. width for the loading of box-car commodities. When the cars are used for the latter purpose, the auxiliary inside door slides over the large automobile door opening, forming a separate wall, and thereby eliminates the installation of any temporary lining. These inside doors are of corrugated-steel construction and are lined with plywood. They fit in a recess in the side wall when not in use in such a manner as not to interfere with the loading of any commodity. The doors have safety catches of the gravity type to hold them automatically in a closed or open position.

Underframes and Trucks

The underframes have the Duryea cushioning arrangement. The center sill consists of two 10-in. open-hearth steel channels with top and bottom cover plates applied with a continuous weld. The side sills are 10-in. high-tensile-steel channels, running from end sill to end sill, with a reinforcement consisting 6-in. bulb angles attached to the side sill under the door opening. The end sills are high-tensile steel angles.

The body bolster is of the built-up type of welded construction having 3/16-in. high-tensile steel web plates and ⅜-in. top and bottom cover plates. The four cross bearers are also of high-tensile steel of welded construction extending the full width of the car. The diagonal bracing is of ⅛-in. high-tensile steel extending from the corner of the car at the junction of the side and end sills to the junction of the bolsters and the center sill. The body center plates are of high-tensile cast steel conforming to the A. A. R. contour, and each plate is held in position by ¾-in. rivets reinforced by welding. Three-inch Z-bars of high-tensile steel form the floor stringers which are welded to the cross bearers and bolster web.

The cars are equipped with self-aligning trucks of the Truck Association design having a spring plankless double-truss frame. The side frames and the truck bols-

ters, made by the American Steel Foundries, are of high-tensile cast steel. The side frames have the brake-hanger bracket cast integral and the latter provides for the application of the Mobil brake-hanger retainer. The side bearings are of the roller type. All helical springs

Principal Weights and Dimensions of the Denver & Rio Grande Western Automobile-Box Cars Built by the Pressed Steel Car Co.

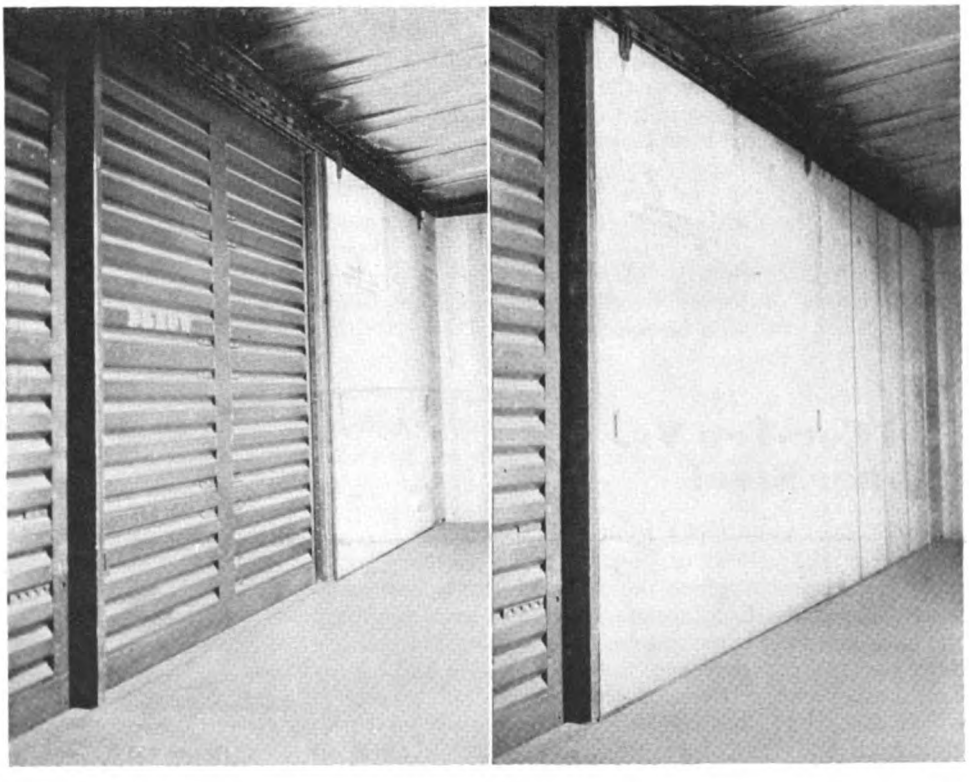
Length over coupler carrier casting, ft.-in.	42-10¾
Length over end sills, ft.-in.	40- 8⅛
Width over side sills, ft.-in.	9- 9⅝
Length, inside, ft.-in.	40- 6$^{1}/_{16}$
Width, inside, ft.-in.	9- 2$^{1}/_{16}$
Width, side door opening, clear, automobile car, ft.-in.	15- 1
Width, side door opening clear, box car, ft.-in.	6- 0
Height, inside at side plate, ft.-in.	10- 8⅛
Height, inside at center, ft.-in.	11- 1$^{3}/_{16}$
Height, rail to top of running boards, ft.-in.	15- 1
Cubic capacity, cu. ft.	3,961
Light weight, lb.	44,000
Load limit, lb.	124,600
Ratio, pay load to gross load, per cent	73.7
Journal sizes, in.	5½ × 10

were furnished by the American Locomotive Company, Railway Steel Spring Division, but 50 cars were equipped with the Holland Volute spring snubbers and the remaining 50 cars with the American Steel Foundries' snubbers. The trucks have one-wear steel wheels, standard A. A. R. journal bearings, pressed-steel journal-box lids, and Jenkins leather fibre dust guards and wedges. Fifty cars have Creco brake beams and the other 50 cars have Davis brake beams. The brake shoes, with reinforced back, are 2 in. thick, and are held by Lockey brake-shoe keys. Schaefer brake hangers of the integral-forged type and the Grip Nut safety support and safety device, with the bottom rod going through the bolster, were installed.

The design of the superstructure follows the recommended A. A. R. practices. The roofs are the Murphy solid-steel riveted type using No. 16 gage USS Cor-Ten steel sheets and ⅛-in. USS Cor-Ten steel caps with a provision for the application of automobile loading de-

Partial List of Materials and Equipment on the Denver & Rio Grande Western Automobile-Box Cars

Underframe	O. C. Duryea Corp., New York
Roof	Standard Railway Equipment Mfg. Co., Chicago
Running boards	Apex Railway Products Co., Chicago
Outside doors	The Youngstown Steel Door Co., Cleveland, Ohio
Ends	Union Metal Products Co., Chicago
Side and end ladders	The Wine Railway Appliance Co., Toledo, Ohio
Floor clips	Western Railway Equipment Co., St. Louis, Mo.
Leak-proof bolts; grip-holding nuts.	Grip Nut Co., Chicago
Coupler	National Malleable and Steel Castings Co., Cleveland, Ohio
Uncoupling rigging	Union Metal Products Co., Chicago
Truck side frames; bolsters	American Steel Foundries, Chicago
Side bearings	A. Stucki Co., Pittsburgh, Pa.
Journal bearings	Magnus Metal Div., National Lead Co., New York
Steel wheels	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Helical springs	American Locomotive Co., Railway Steel Spring, Div., New York
Snubbers	(50) Holland Company, Chicago (50) American Steel Foundries, Chicago
Brake hanger retainer	Illinois Railway Equipment Co., Chicago
Brake beams	(50) Chicago Railway Equipment Co., Chicago (50) Davis Brake Beam Co., Johnstown, Pa.
Brake shoe; brake shoe keys (Lockey)	American Brake Shoe & Foundry Co., New York
Brake hangers	Schaefer Equipment Co., Pittsburgh, Pa.
Air brakes, type AB	Westinghouse Air Brake Co., Wilmerding, Pa.
Hand brake	Ajax Hand Brake Co., Chicago
Brake step	Apex Railway Products Co., Chicago
Brake regulator	Royal Railway Improvements Corp., New York
Journal box lids	American Locomotive Co., Railway Steel Spring Div., New York
Dust guards; wedges	Portable Plating & Equipment Co., Chicago
Angle-cock holder; defect card holder; pipe clamps	Railway Devices Co., St. Louis, Mo.
Retainer pipe clamp	Illinois Railway Equipment Co., Chicago
Safety support and device	Grip Nut Co., Chicago
Draft-key lock	Illinois Railway Equipment Co., Chicago
Paint and primer	(50) E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. (50) Wardway Paint Works, Chicago Heights, Ill.
Paint and primer, roofs	The Glidden Co., Cleveland, Ohio



Left: When the car is used for the transportation of automobiles the inner door slides back in a recess in the side wall—Right: The inner door is in position for the loading of grain and other box-car commodities

vices. The Apex steel running boards, made in sections and fitting between the roof seam caps, and steel latitudinal running boards were applied. The outside doors were made by the Youngstown Steel Door Company and are fitted with roller lift fixtures. The cars have Dreadnaught two-piece steel ends with round corners with the top and bottom sections of 1/8-in. and 5/32-in. USS Cor-Ten steel, respectively. The side sheets are of No. 14 gage USS Cor-Ten which are riveted to the posts as well as to the side plates and side sills.

The flooring consists of fir with a 5¼-in. face having calking cement on the ends of the boards with the top of the floor sanded. The floor boards are held in position by floor clips, leak-proof bolts, and grip holding nuts. The side lining is of 25/32-in. fir, tongue and groove running horizontally, with the lining in the pocket behind the inside door of ¾-in. plywood. The end lining is also of 25/32-in. fir running vertically.

The cars are equipped with Type-E rotary couplers of the bottom-operating type made of Grade B cast steel by the National Malleable and Steel Castings Company, draft keys of open-hearth steel, and the Imperial rotary uncoupling rigging. The brake equipment is comprised of the Westinghouse Type-AB air brake and the Ajax vertical-wheel hand brakes. The side and end ladders were furnished by the Wine Railway Appliance Co.

A Study of The Locomotive Boiler

(*Continued from page 51*)

pass through this furnace in 0.1 second and this is one of the reasons for the great loss of carbon at high-capacity operation. As a comparison, in stationary practice the velocity of the gases just before entering the tube bank is about 10 m.p.h. at a maximum. A study of the designs of many recent boilers indicates that the width of the firebox, as well as the depth, could have been increased to give the advantage of a larger combustion volume under the firebrick arch, as well as a larger gas area between the top of the arch and the crown sheet.

A few modern boilers have been built with a firebox ring as low as 53 in. from the rail which, with a horizontal grate, would give a good depth of the firebox at the rear. On many locomotives with the grate sloping up toward the back end, the distance from the rail to the firebox ring is 72 in., or more, and thus there is a loss of 18 in. in the depth of the firebox. The author has not been able to get a satisfactory reason why sloping grates are still continued. Many boilers have been built with horizontal grates and have given satisfactory service.

(*To be concluded*)

USS Cor-Ten Vs. Copper Steel

(*Continued from page 61*)

with their relatively short life, represent one extreme of intensive service in which the effect of atmospheric corrosion in relation to total deterioration is at a minimum and abrasion is at the maximum. At the other extreme are those parts of cars which receive no abrasion and last as long as they can resist atmospheric corrosion. Tests in which steels have been subjected to exposure in rural, industrial, and sea-coast atmospheres without abrasion have shown that, under these conditions, Cor-Ten has two to three times the life of copper steel. It is noteworthy that in the hopper-car test described above, where conditions are so different, Cor-Ten again shows almost the same degree of superiority. Because the two types of tests representing opposite extremes of service conditions give such similar results, it is believed that it is conservative to estimate that in any application in freight-car construction Cor-Ten will develop approximately twice the life that would be obtained from the same thickness of copper steel.

Baldwin Diesel-Electric Switchers

(*Continued from page 59*)

plates with shims for adjustment. Alemite grease lubrication is applied to the truck center pin and oil lubrication is used for the pedestal gibs and journal thrust bearings. The trucks are equipped with clasp brakes.

The equipment ahead of the cab is covered by a 68¼-in. hood built of sheet steel on a steel frame and designed with doors on the sides. The doors are equipped with latches and locks, are hinged and when open give access, by means of the 25-in.-wide roughened plate platform inside of the hood, to all equipment located therein. Ventilation is effected through screened and baffled side openings. The hood is equipped with top inspection hatches and with lifting bales for removing it as a complete unit. Permanent inspection-light fixtures are located inside the hood.

The air-brake equipment is Westinghouse Schedule 14-EL. Both straight and automatic air brakes operate on all wheels. There are two air reservoirs with a capacity of 60,000 cu. in. The locomotives are equipped with one Ajax hand brake with a hand-wheel located in the cab and connected to the brake rigging of one truck to hold the locomotive while out of service.

Compressed air is furnished by a Gardner-Denver three-cylinder two-stage air-cooled compressor having a displacement of 56 cu. ft. of free air per minute at an engine idling speed of 250 r.p.m., and 140 cu. ft. at full engine speed of 625 r.p.m. The air compressor is driven by a Thomas coupling from the generator shaft.

Accessories used on these locomotives include the following: Miner A-22XB friction draft gear; National Type E swivel shank, top-operating couplers; 12-in. bell with internal, quick acting pneumatic ringer; Pneuphonic horn; Sunbeam headlights and Leach Type D pneumatic sanders.

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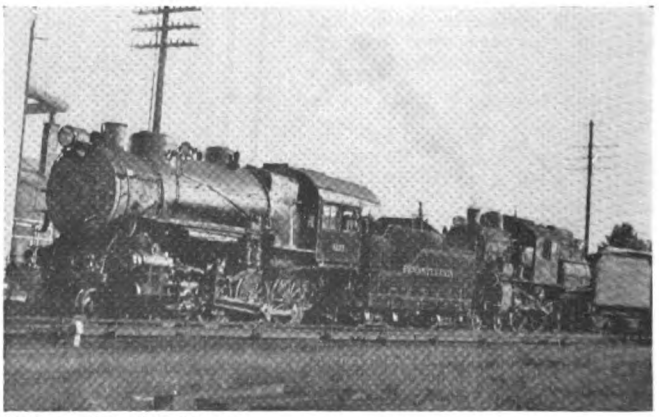


Photo by Granville Thomas

On the Pennsylvania-Reading Seashore Lines at Millville, N. J.

EDITORIALS

Locomotive Availability

In motive-power economics the outstanding advantage of the steam locomotive is its relatively low first cost. In road service where the locomotive unit must have approximately the same horsepower capacity, whether steam or Diesel-electric, the first cost of the Diesel unit will range from two and one half to three times that of the steam locomotive. One of the strongest claims for the Diesel-electric locomotive, however, is its high degree of availability as compared with that of the steam locomotive, which is an offsetting factor.

There is no opportunity to compare the degree of intensity with which steam and Diesel-electric locomotives are used in freight service since the Diesel-electric locomotive has not yet accumulated any records in this service. In passenger service, however, data enough are available to give some indication of the possibilities which the Diesel-electric locomotive offers in this respect.

During 1939 an ownership of 7,320 steam passenger locomotives averaged 45,000 miles per year per locomotive. This is an average of 3,750 miles per locomotive per month, or 125 miles per locomotive day on the basis of ownership. The report of the Committee on the Utilization of Locomotives presented at the meeting of the Railway Fuel and Traveling Engineers' Association last October quoted an average daily mileage per *active* passenger locomotive during the first six months of 1939 of 183.5. The best average mileage for a single railroad was 269.7 per active locomotive day and the lowest 144.7.

Compare this with the performance of Diesel-electric passenger locomotives during 1939. The 58 locomotives in passenger service (as of June 30, 1939) averaged 178,600 miles per year. This is equivalent to 14,900 miles per month and 497 miles per day. While this number of locomotives probably does not accurately represent the total number of locomotive days during the year because of additions during the last half of the year, the error is not believed to be large. In each of 1937 and 1938, with a much closer average of the number of locomotive days and a much smaller total locomotive mileage, Diesel-electric locomotives averaged well over 400 miles per day.

In interpreting these figures account must be taken of the fact that they represent the aggregate performance of a number of individual units assigned to runs on which the conditions are ideal for a high degree of utilization, whereas the steam-locomotive performance represents complete power assignments in which are included spare power and runs on which high mileages are impossible. But even when the active steam locomotive mileage is compared with the mileage of the Diesel-electric locomotives owned, the mileage performance of the latter is outstanding.

This situation suggests that one of the most important factors in the future development of the steam locomotive must be the improvement of its capacity for more intensive utilization. Indeed, it is a question if the steam locomotive is not, in this respect, a victim of its own history. Until 20 years ago scarcely anyone thought it practicable to operate a steam locomotive over more than a single crew district. Even before long runs were being taken into account in locomotive design, however, the steam locomotive demonstrated its capacity for runs as long as traffic and road characteristics permitted. Some of the more recently built locomotives have demonstrated their ability to remain out of the shop for classified repairs for well over 200,000 miles. It does not seem beyond the possibilities of the future to remove some of the other limitations on continuity of service which still have to be contended with.

Steam and Diesel Locomotive Comparisons

In a comment on the comparison of the performance and operating costs of Diesel-electric locomotives and steam locomotives in these columns last month, comparisons on three points were discussed. These were the question of fuel cost, the question of the horsepower-weight ratio, and the cost of maintenance. No mention was made in this discussion of the relative effect of first cost when the comparison is between the Diesel-electric locomotive and the new steam locomotive for the same service.

In considering this aspect of the relative economic value of the Diesel-electric and steam motive power there are really two comparisons which have to be considered in every specific instance. The first is that between the old motive power by which the service is now being performed and the proposed new steam motive power. The second is between the proposed

Diesel-electric motive power and the existing steam motive power. The effect of the value of the existing steam motive power on such first-cost comparisons will depend on its bookkeeping status. If all of its first cost, except the usual allowance for recoverable scrap value, has been recovered through depreciation charges, the ultimate effect on the accounting of the retirement of the existing power and its replacement with new will be in the property account and will be the difference between the first cost of the new power to be purchased and the original cost of the existing power. If, however, the existing power has been subject to inadequate depreciation charges, a retirement charge will have to be made in operating expenses, as a part of the transactions involved in replacing the old power with new. This will operate against the new power only during the year in which it is made. In setting up the comparison, however, the undepreciated portion of the first cost of existing equipment is sometimes added to the first cost of the new equipment for the determination of the carrying charges which must be earned by the new locomotives before they can be considered as moneymakers. In any case, the ultimate comparison between the Diesel-electric locomotives and the new steam locomotives would involve the balancing of the difference in their operating costs against the carrying charges on the difference in their first costs.

In the case of switching locomotives, the difference in first cost of new motive power of the two types would be at its lowest and operating advantages probably the most favorable to the Diesel-electric locomotive. In the case of road locomotives, with the horsepower capacity of the two types about equal, the difference in first cost will be greater and operating costs less favorable to the Diesel-electric.

In either case, however, the carrying-charge handicap of the Diesel-electric is less when compared with a new steam locomotive than when compared with an old steam locomotive, the first cost of which has been partially recovered through depreciation.

The Designer Must Consider Maintenance

One of the points stressed by C. A. Brandt, chief engineer of the Superheater Company, in his paper on the locomotive boiler presented at the 1939 annual meeting of the American Society of Mechanical Engineers, was the importance of obtaining as large a gas area as possible through the boiler. The reasons for this are discussed in Mr. Brandt's paper, the first part of which appears elsewhere in this issue. There are also logical reasons why a large gas area may create conditions which are undesirable from the standpoint of maintenance.

In presenting the committee report on What Is the Real Cause for Flues Cracking Longitudinally Through the Beads at the 1939 annual meeting of the Master Boiler Makers' Association, Chairman E. E. Owens stated "It is felt by many, especially the boiler maintainers, that the engineer designing the boilers is too prone to obtain the greatest amount of flue gas area, possibly by crowding in flues to the extent that the water space between the tubes and flues is too close and with a small accumulation of scale the circulation of water is restricted to a point where the heat is not absorbed fast enough, allowing the beads and flue ends to become overheated." It was the committee's suggestion that consideration be given to the spacing of flues with as liberal a bridge as possible and also that the tubes and flues should not be staggered to the extent that washing out between the rows could not be readily accomplished.

No matter how well designed a locomotive boiler may be from the standpoint of ideal proportions, it cannot be safely and efficiently operated without current inspections, tests, and repairs. It is important, therefore, that it be designed to facilitate its maintenance, and thus decrease the time required to perform these necessary operations. The designer who ignores this fact will not only increase the maintenance costs but will also reduce the locomotive's availability, an important competitive factor today.

Boiler Explosions

In the report of the Chief Inspector of the Bureau of Locomotive Inspection for the fiscal year ended June 30, 1939, which is reviewed in this issue, are reported six locomotive boiler explosions caused by crown-sheet failures due to low water. In only two of these were contributory causes or defects found. This is not out of line with the records of the immediately preceding years when, in 1938, five such accidents were reported and, in 1937, eight reported, in three of which contributory causes or defects were found. During the past fiscal year 12 were killed and 11 injured in these accidents; in 1938, 5 were killed and 3 injured; in 1937, 13 were killed and 8 injured. The past year, therefore, shows no significant change either in the number of accidents or in the number of resulting casualties.

Considered together, the three years might imply that an irreducible minimum of such accidents in which no contributing causes or defects are found has been reached at about four or five per year. But accidents of this kind which have occurred since the close of the last fiscal year, on which reports have been issued by the Bureau, leave one with the uneasy suspicion that such a minimum is going to be exceedingly hard to maintain. Reports have been issued on four accidents resulting from crown-sheet failures due to low water

in the investigation of which no contributory causes or defects were found, all of which occurred in a period of about three and one half months since September 26 last. These accidents were the causes of seven deaths and ten injuries.

Accidents of this kind are an exceedingly old story and, considering the matter in a statistical sense, a minimum of four or five per year in operations involving over 40,000 locomotives scattered over an area as wide as the United States may be considered highly satisfactory. Considering the amount of human suffering which is inevitably caused by these accidents, however, the continuance of even one such accident per year must be a cause of serious concern, not in the least mitigated by the fact that the seat of the trouble in many of them lies with the men who suffered most. An attitude of callousness and indifference either on the locomotive or in the shop and engine terminals is the source of so much of the difficulty that a continuous fight must be waged against it.

Journal-Box Temperatures

In a paper before the annual meeting of the American Society of Mechanical Engineers, which is abstracted in this issue, E. S. Pearce presents interesting test data showing the distribution of the heat generated by journal friction, by means of temperature readings taken at 53 locations within the journal box. In general, it may be said that the temperatures accurately measured on the test plant show what would be expected in a qualitative sense from the very character of the journal box and its contents—the journal, the brass, the wedge and the packing.

An interesting point which the tests bring out, however, is the effective part which the movement of the air about the journal box plays in the dissipation of the heat generated from normal operation of the journals in their bearings. In a comparison of the operation of a waste-packed box in air movement equivalent to the speed in miles per hour at which the journal was operating with its operation in still air, temperatures in the moving air 30 to 40 deg. lower were measured in the walls of the journal box. Nearly as great temperature differences were observed in the journal-box packing and the temperatures at the most critical points of the bearing surfaces are about 20 deg. lower at speeds of 40 and 60 miles an hour; even at 20 miles an hour the difference is as high as 10 deg.

What is of greater importance, however, is the clear demonstration that the successful performance of waste-packed journal boxes depends upon careful adherence to those fundamentals which control the generation of heat at the source: clean and properly saturated journal-box packing, skillfully applied in the box.

New Books

A. S. T. M. Specifications for Pipe and Piping Materials. *Published by the American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa. 143-page binder with heavy paperboard cover. Price* $1.25.

These specifications for pipe and piping materials for high-temperature and high-pressure services cover various types of carbon and alloy-steel pipe and boiler tubes, etc., including specifications for classification and dimensions of wrought-iron and wrought-steel pipe; carbon and alloy-steel castings for valves, flanges, and fittings; forged or rolled alloy-steel pipe flanges; alloy-steel bolting materials, and carbon and alloy-steel nuts.

Wrought Iron, Its Manufacture, Characteristics and Application. *By James Aston and Edward B. Story. Published by the A. M. Byers Company, Pittsburgh, Pa.* 100 *pages,* 6¼ *in by* 9¼ *in. Price* $1.

Several new chapters have been added to the second edition of this book, written to serve as a source of up-to-date information on wrought iron for all who are interested in problems of material selection as well as for students in colleges and universities who may some day become responsible for engineering specifications. The book now contains twelve chapters on wrought iron; its characteristics; early and present-day manufacture; the introduction of other ferrous metals; quality standards; specifications and durability testing; forging and bending; welding, etc.

Proceedings of the 1939 Annual Meeting of the Master Boiler Makers' Association. *Albert F. Stiglmeier, Secretary, 29 Parkwood Street, Albany, N. Y. 263 pages. Price, $3.*

This book contains the official proceedings of the twenty-sixth annual meeting of the Master Boiler Makers' Association held at the Hotel Sherman, Chicago, October 17, 18 and 19, 1939. Included in the proceedings are the addresses given by railroad and government officers, three lectures, and eight technical reports. The lectures were delivered on the subjects of embrittlement in the locomotive boiler, circulation of water in the boiler, and the action of steam and water inside the boiler. The technical reports are given in detail and contain information on the training of boilermaker apprentices, welding and alloy steel in locomotive tender construction, circulation of water in the boiler, chemical feedwater treatment, methods for locating the height of crown sheet and water-level indicating devices, the cracking of flues and tubes through the beads, the inspection and cleaning of air reservoirs, and methods for renewing fireboxes. The discussions of these reports by members are also included.

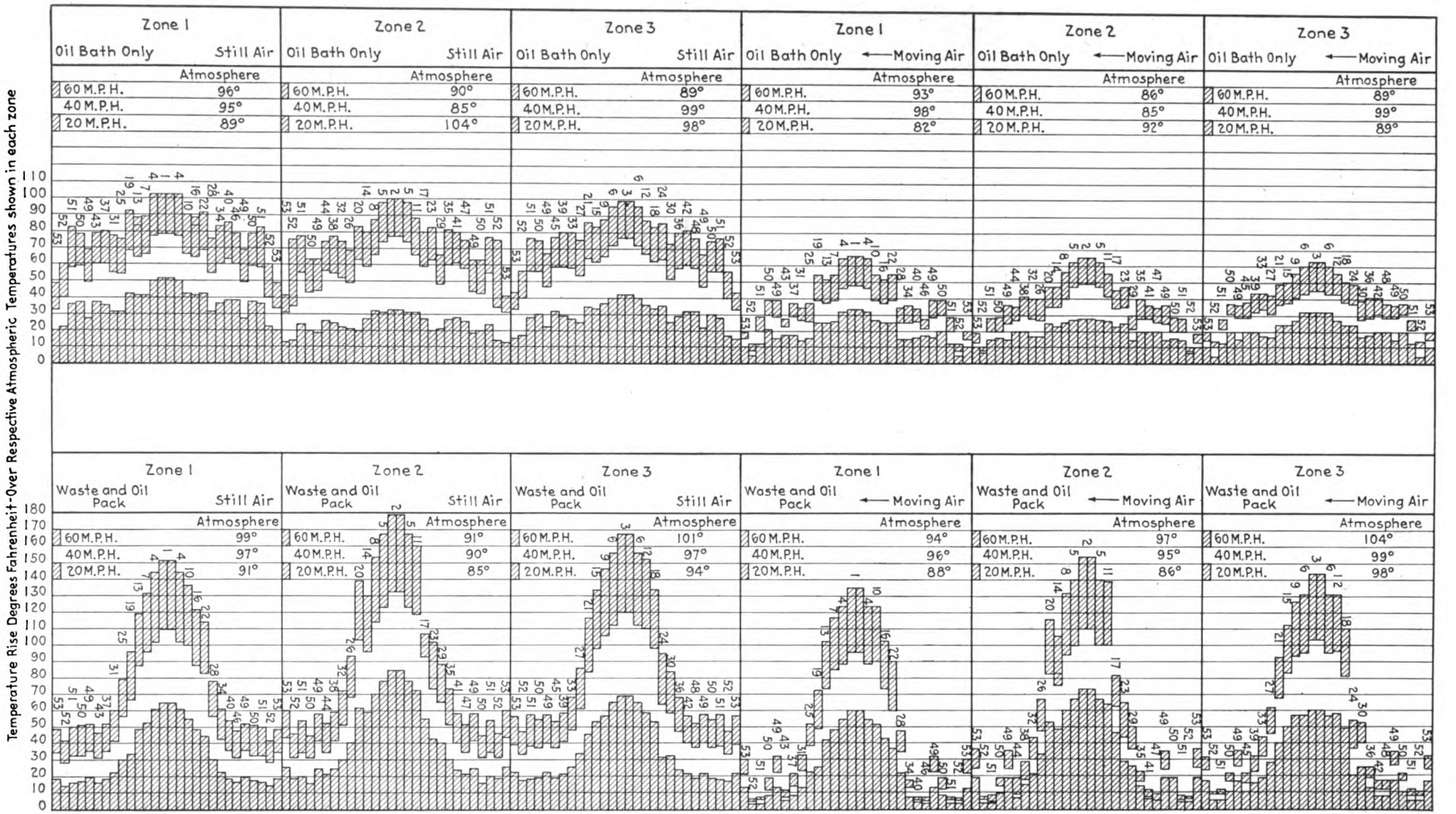


Fig. 1—Temperature distribution in a standard railway journal-box assembly

With the Car Foremen and Inspectors

Distribution and Sources of

Journal-Box Temperature*

By E. S. Pearce†

THE purpose of this paper is to set forth certain data illustrative of the distribution of heat generated in the conventional railway journal-box assembly. These data have been collected collaterally with an extended investigation of heat causes or sources and their control in journal-bearing operation on railroad rolling stock. In a sense, this is an uninterrupted continuation of research and development work described in a previous paper by the author.‡

The same plant and equipment, as described in that paper, were used for these tests, the amplification of equipment being the application of some 53 thermocouples to a 5½- × 10-in. journal box and contained parts. Fig. 2 shows diagrammatically the exact location of all the thermocouples and their numerical designation. Thermocouples Nos. 7, 8, 9, 10, 11, and 12, Fig. 2, are located in the bearing surface to obtain oil-film temperatures.

The preparation for these tests consisted of packing the journal box in the conventional manner with a good grade of wool packing, saturated with oil in the ratio of 3¼ lb. of oil per lb. of waste. The car oil used was of a standard brand, having a viscosity of 45 sec. Saybolt at 210 deg. F. The combined quantity of waste and oil weighed 8 lb., consisting of 1⅞ lb. of waste and 6⅛ lb. of oil. Conventional standard A.A.R. 5½- × 10-in. journal bearings, broached to insure a fixed width of crown, were used. All tests were conducted under a fixed total load of 20,000 lb., giving a unit loading of 890 lb. per sq. in. of projected actual bearing area.

Tests were run at operating speeds of 20, 40, and 60 m.p.h., equivalent to 268, 536, and 804 ft. per min. journal surface speed, with 186, 372, and 558 r.p.m., respectively. A continuous run of seven hours was made at each respective speed, at which time all temperatures recorded were at their stabilized maximum. These temperatures are shown in Fig. 1. Atmospheric temperatures were maintained within practical limits at approximately those of high summer temperatures. Tests were duplicated under conditions of still air and

(Continued on page 73)

* An abstract of a paper presented on December 6, 1939, at the annual meeting of the American Society of Mechanical Engineers at Philadelphia, Pa.

† President, Railway Service and Supply Corporation.

‡ "Locomotive and Car Journal Lubrication," by E. S. Pearce, Trans. A. S. M. E., vol. 58, 1936, pp. 37-45.

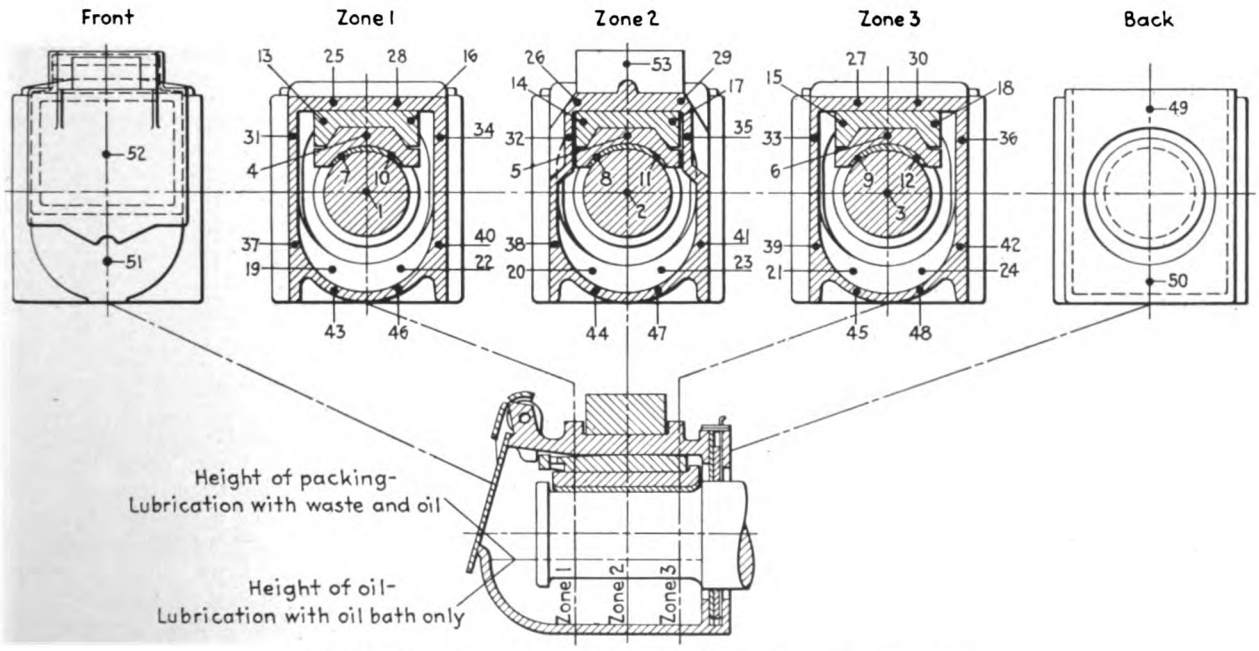
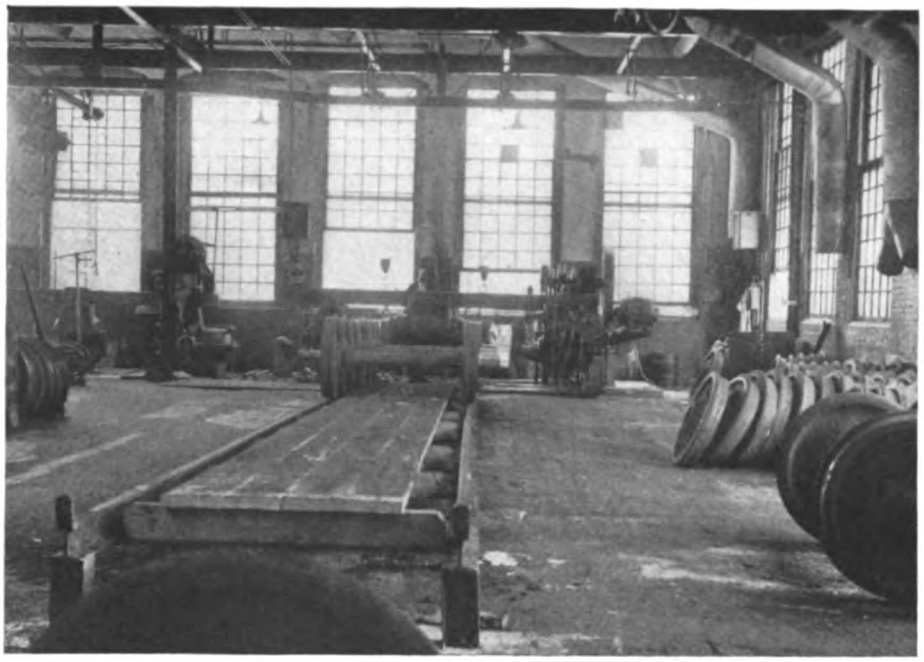


Fig. 2—Location of thermocouples in standard railway journal-box assembly



The inclined runway as seen from the loading end

Improvements At the Readville Shop Facilitate

Demounting Wheels

In the March, 1936, issue of the *Railway Mechanical Engineer,* an article was published describing the general arrangement and system of operation of the New York, New Haven & Hartford system wheel shop located at Readville, Mass. At the time that article was prepared it was recognized by those in charge of the shop that, while the output was generally satisfactory, there were obstacles in the way of necessary increases in output that would provide the reserve shop capacity quite often needed under unusual conditions. From the standpoint of wheel boring, turning and grinding; the machining of axles and the mounting of finished wheels and axles the shop facilities were entirely adequate. So also was the general arrangement for the handling of wheels and axles within the shop. The opportunity for the greatest improvement appeared to be in the methods used in the demounting of wheels as they came to the shop. It is with the solution of this demounting problem that this article is concerned.

Readville Wheel Shop Production—Six Months, 1939

	1	2	3	4	5	6
Cast-iron wheels bored, (no. of wheels)	1,186	576	1,322	1,196	1,086	992
Steel wheels bored, (no. of wheels)	312	434	328	253	248	282
Axles turned and burnished	822	559	977	771	694	626
Treads ground on mounted cast-iron wheels, pairs	22	21	8	15	8	10
Treads ground on mounted steel wheels, pairs	18	17	6	10	14	23
Treads turned on mounted steel wheels, pairs	181	242	282	199	199	194
Journals turned and burnished, mounted wheels, pairs	232	194	231	203	281	210
Cast-iron wheels demounted, pairs	870	555	1,314	1,290	1,950	1,877
Steel wheels demounted, pairs	156	129	105	150	159	154
Cast-iron wheels mounted, pairs	592	283	650	569	540	493
Steel wheels mounted, pairs	116	195	151	94	86	109
Roller bearing wheels serviced, pairs	30	21	81	66	43	37
Eight-hour days worked	21	19	23	20	22	22
Average number of men in wheel shop during month	20	18	20	20	18	18
Average number of pairs of wheels turned out of shop per day	51	39	53	50	47	47

The Change in Facilities

Reference to the shop layout drawing, which appeared on page 113 of the March, 1936, issue, will show that the demounting operations were carried on, under the old arrangement, with one single-end press. The wheels were inspected and checked in the incoming cars just outside the north side of the shop and were delivered, by the two-ton monorail crane, to the floor inside the shop adjacent to the demounting press. After the wheels were placed on the floor in the shop, all of the handling operations were manual, both to the press and after the wheels were demounted. This manual labor, with the one single-end press, constituted a serious handicap.

In considering plans for the re-arrangement of the shop, these two factors were kept in mind. Reference to the shop drawing accompanying this article will show how the wheel demounting department has been changed. The single-end demounting press was moved to the west wall of the shop and, in the corner adjacent to this lo-

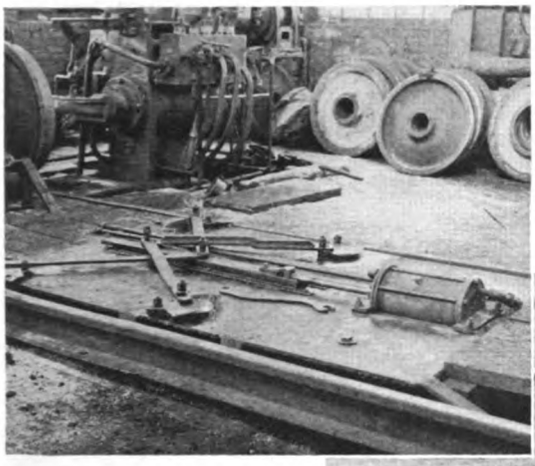
cation, a Chambersburg double-end demounting press was installed. The necessity for manual labor in the handling of wheel sets to this mounting press and the disposal of wheels and axles from the press was largely eliminated by the installation of three devices—a 55-ft. inclined runway feeding wheel sets to the press; two wheel chutes, or runways, for the demounted wheels destined for the scrap car, and an axle chute from the press to the floor. The demounted wheels routed to points within the shop for subsequent use are handled by the overhead monorail.

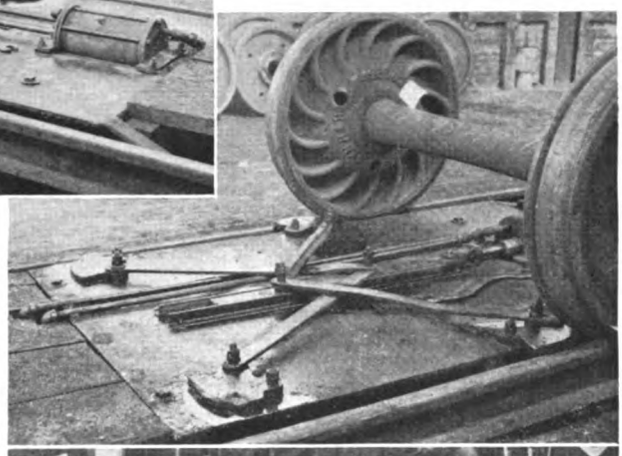
The location of this overhead monorail was changed, in the demounting section, to accommodate the new location of the presses.

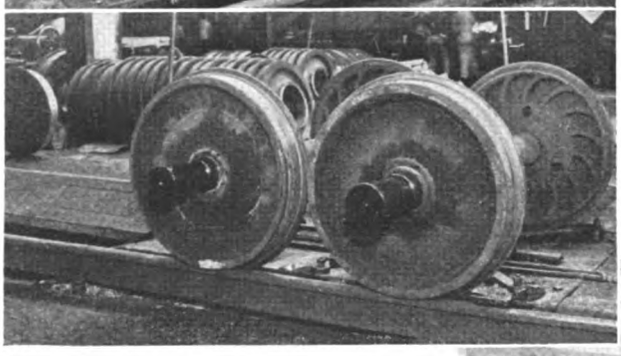
The Inclined Runway

The inclined runway, which now feeds the wheel sets to the double-end press, has a total length of 55 ft. and a slope of 10 in. in that distance. It consists of an elevated standard-gage track with a walkway of planks between the rails. The construction is clearly shown in the illustrations. The entire runway has a capacity of 17 pairs of mounted wheels. This is the number that can be loaded on the special wheel cars now used on the New Haven between outlying points and the central wheel shop at Readville. In operation, the 17 pairs of wheels are unloaded from the wheel car outside the north side of the shop by the two-ton Shepard monorail crane. This crane system serves the entire wheel shop, both inside and out. The wheels are picked up, a pair at a time, and brought into the shop and deposited at the high end of the runway. Each pair is then rolled down, under control, to a pneumatically-operated wheel stop device which controls the movement of the wheels to the press one pair at a time. One of the illustrations shows the arrangement of this device which consists of an air cylinder and two pairs of cam-like wheel stops. The device is controlled by a two-way valve which, in one position, throws the upper stops across the runway rails. When the valve is in the other position, the wheel sets can run down the way to the lower set of rail stops. Under this condition the entire trackful of wheels on the runway can move down one step nearer the wheel press.

A pneumatic control valve is conveniently located at the end of the press. When a pair of wheels has been demounted and the wheels and axle disposed of, the valve is moved to the proper position and the lower rail stops move away and permit the pair of wheels nearest the press to roll off the runway end into the press. The control valve is then moved to the other position and the lower rail stops move across the rails while the upper stops clear the rails, thus allowing the line of wheel sets on the incline to move ahead toward the press. The rail stops are so spaced that when the lower stops clear the rails, the upper stops prevent another pair of wheels from moving down the incline.

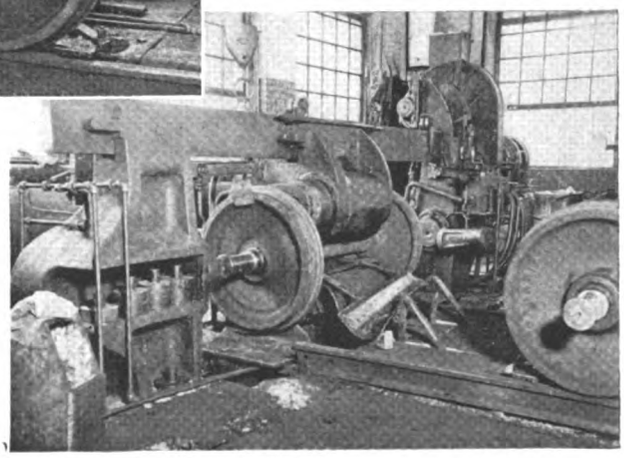


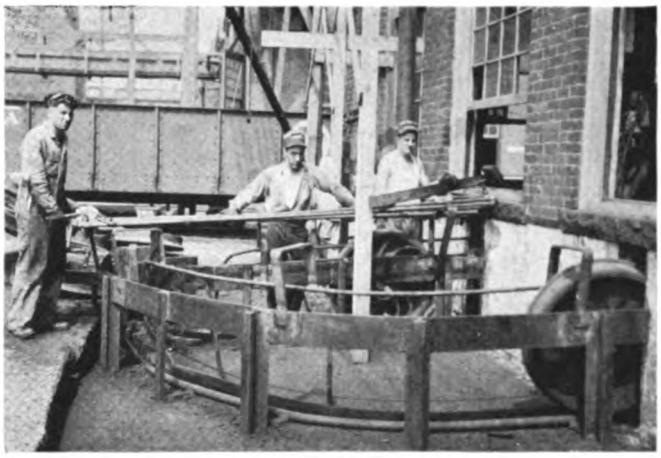




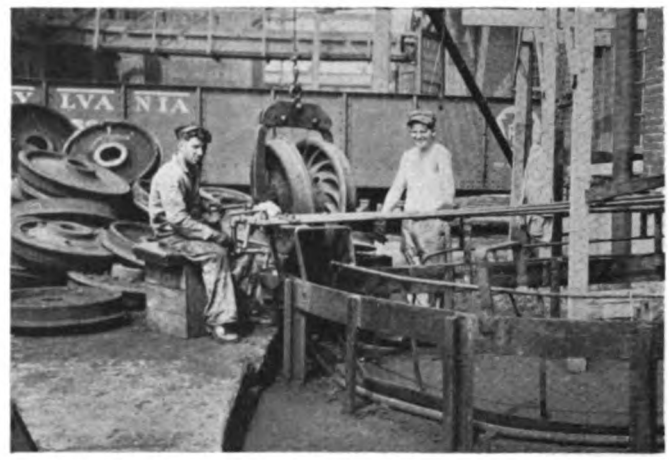
The wheel stop and feeding device which controls the movement of the line of 17 pairs of wheels on the inclined runway consists of an air cylinder and four cam-like stops which move over the rail. In the illustration above the lower stops are across the rails and the upper stops clear

The wheels roll down the incline and are held by the upper rail stops as seen in the upper view at the left. When the two-way valve controlling the mechanism is changed to the other position the lower stops block the rail and clear the upper position, as seen in the lower view at the left. After the wheels have been demounted from the axle the latter slides out and down the chute seen in the view below





Arrangement of the wheel chutes outside the shop, showing how the two wheels come through the wall openings

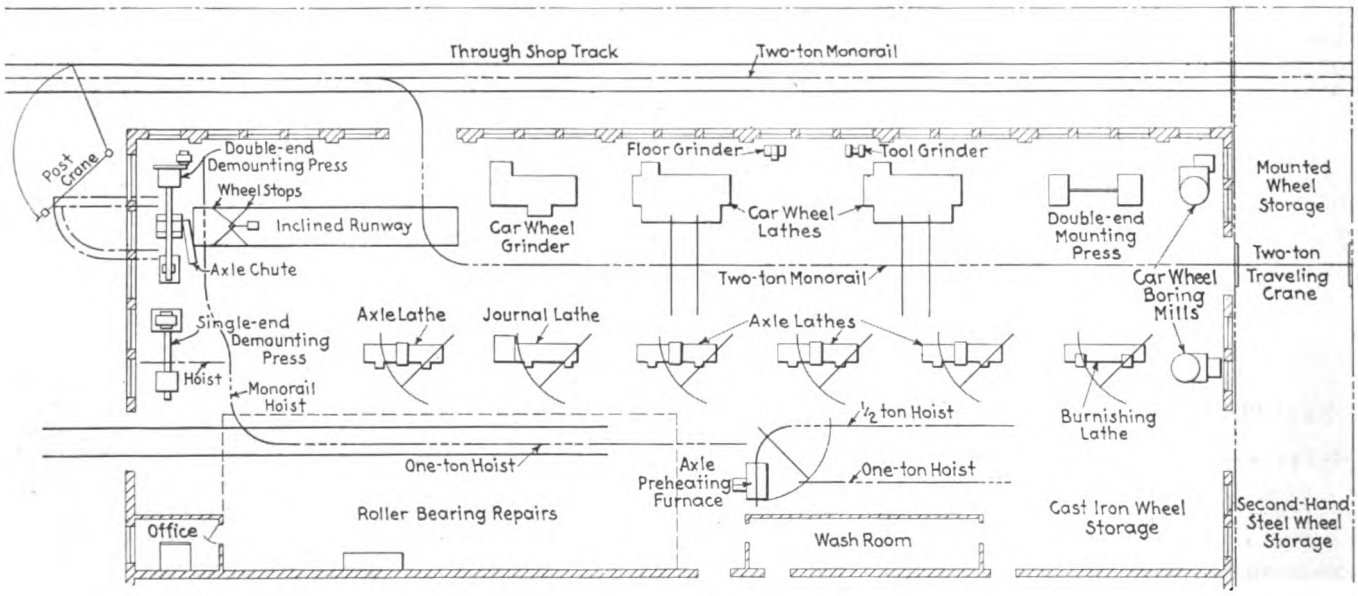


When the wheels reach the central point they are picked up by an air hoist and special lifting device

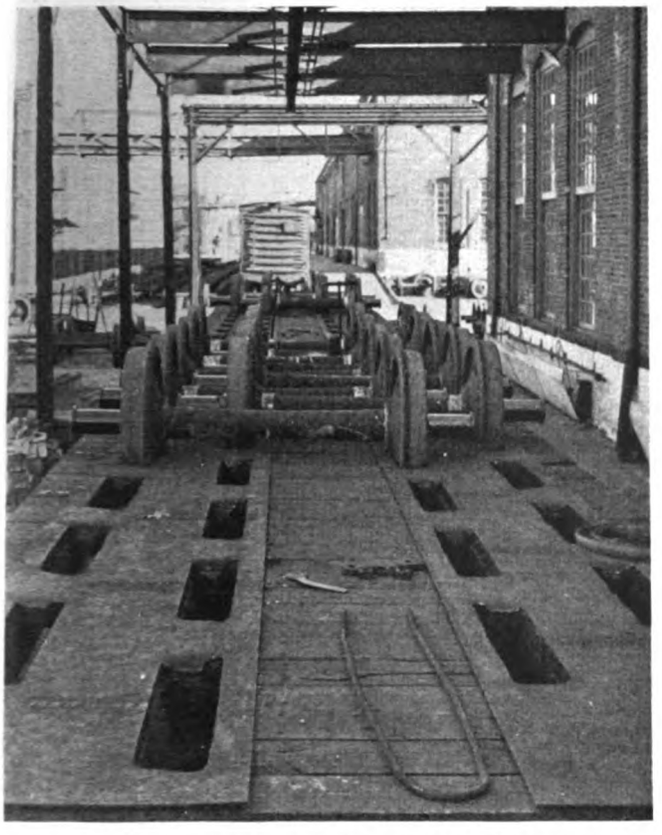


Loading scrap wheels into a car. The hoist controls are handled by the operator in the foreground

When the wheels have been demounted, the two wheels, if they are to be scrapped, drop off the ends of the axle into the chute and roll out through openings in the wall of the shop to a position where they are picked up by an air hoist on a post crane and swung into a scrap car. Demounted wheels which are not to be scrapped are picked up from the press by the overhead hoist and taken to the desired location in the shop. The axle rolls out of the press into a greased chute down which it slides out onto the shop floor. From there it is picked up and



Layout of the Readville wheel shop, showing new demounting facilities



Wheel car used for transporting wheel sets from outlying points—17 pairs make up a car load

taken to the axle lathes, or otherwise disposed of. The illustration shows the arrangement of the scrap-wheel troughs and the guides which direct the single wheels outside the shop. The photographs, showing the outside arrangement, were taken shortly after the new arrangement was installed. During the winter months the outside facilities are covered over as a protection against the weather.

Wheel Handling Cars

Prior to the re-arrangement of the wheel shop facilities it was the practice on the New Haven to load wheels on cars and block them in the conventional manner. One of the illustrations shows a wheel car which has since been designed for the handling of 17 pairs of wheels without the necessity of any blocking. By the use of this car considerable labor and material expense in wheel handling has been eliminated.

Reference to Table II in the March, 1936, issue shows what the Readville wheel shop was doing at that time from the standpoint of output. The table in this article shows the shop performance during six months of 1939. An analysis of the demounting operations will show that it is now possible to demount more than 45 per cent more wheels than was possible with the old facilities.

Air Brake Questions and Answers

D-22-A Passenger Control Valve (Continued)

546—*Q.—What takes place when the packing cup uncovers the slack-adjuster port in the brake cylinder?* A.—When this port is so uncovered, brake-cylinder air flows through the pipe into the slack-adjuster cylinder forcing the slack-adjuster piston outward, compressing its spring. Attached to the piston stem is a pawl extending into the casing, which engages a ratchet wheel, mounted within casing on a screw.

547—*Q.—What happens when the brake is released?* A.—When the brake is released and the brake-cylinder piston returns to its normal position, the air pressure in the slack-adjuster cylinder escapes to the atmosphere through the pipe and the non-pressure head of the brake cylinder, thus permitting the spring to force the slack-adjuster piston to its normal position. In so doing, the pawl turns the ratchet wheel on the screw thereby drawing the cylinder lever slightly in the direction of the slack-adjuster cylinder, thus shortening the brake-cylinder piston travel and forcing the brake shoes nearer the wheels.

548—*Q.—What provides against movement of the ratchet wheel due to vibration?* A.—Ratchet pawls mounted on a floating ring, the end of one of the two levers being held in contact with a tooth in the slack adjuster by a spring.

549—*Q.—What is provided for hand adjustment?* A.—A trip is provided to disengage the holding lever when making a hand adjustment in either direction, a pull of sufficient force being required that, while unlocking is accomplished without undue effort, there is enough movement required and adequate resistance to insure against false movement due to vibration.

550—*Q.—What should be the adjustment if the brake cylinder is mounted on the body?* A.—The piston travel should be adjusted to 7½ in.

Distribution and Sources of Journal-Box Temperature

(*Continued from page 69*)

under conditions of moving air, the velocity of the air being proportional to speed, and blowing against one side of the box in the conventional manner obtaining with the journal box under actual service.

For reference purposes, tests were run with the journal submerged in an oil bath to a depth of one inch, indicated in Fig. 1 as "oil bath only," such tests being designated by this term. The same cycle was used as with the conventional waste pack. A sample comparison, in terms of temperature rise above atmospheric temperature, is shown in Fig. 2 for the temperature at each of the 53 thermocouple locations, as shown by Fig. 1. The temperatures shown in Fig. 2 represent in each case the maximum temperatures obtained after seven hours of continuous running at each respective speed under high atmospheric temperatures.

In general, the center of the journal has the highest temperature; the bearing has the next highest temperature; then, the oil film between the two; and then, the wedge on top of the bearing. The packing temperature is lower than the wedge and lower than the oil-film temperatures. The temperature of the top of the box is lower than the wedge and the waste-pack temperatures.

The comparative temperatures, shown in Fig. 2, are not a measure of the relative proportion of friction losses between perfect bath lubrication and waste-pack lubrication. They have no significance in this respect at all. At 20 m.p.h., the difference in friction loss between bath lubrication and the waste pack was 3.25 per cent; and at 40 m.p.h. it was 1.06 per cent, bath lubrication having the lowest loss. At 60 m.p.h., the difference was 1.6 per cent, the waste pack having the lowest

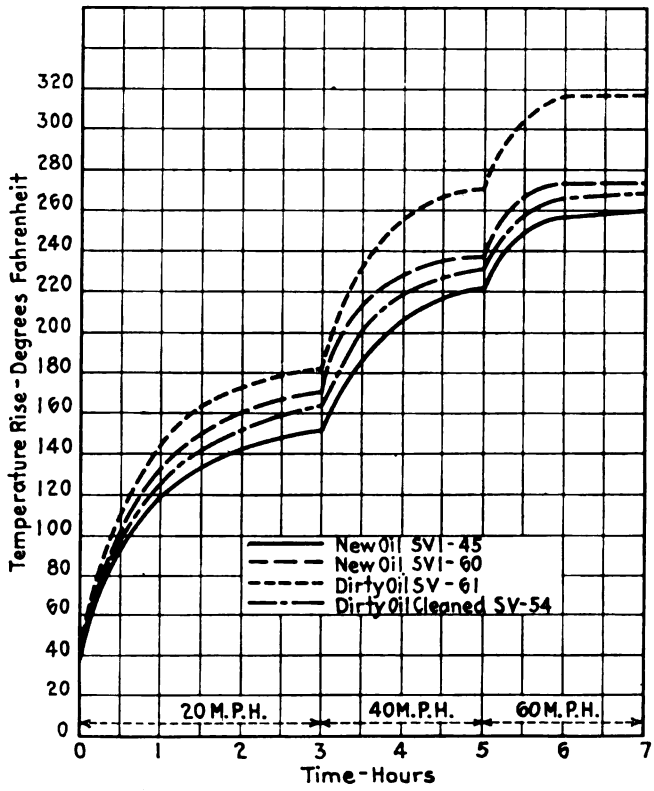


Fig. 3—Temperature at center of journal under no load and without bearing

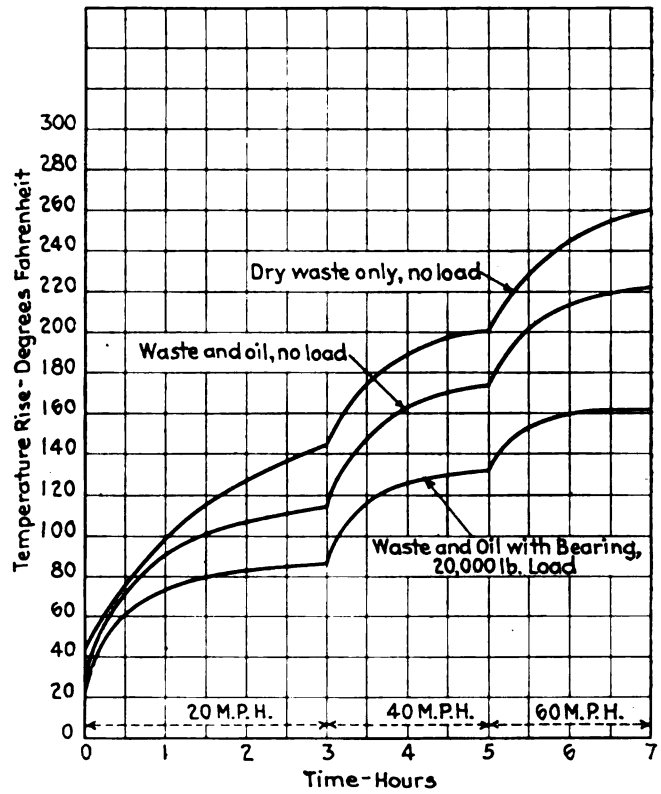


Fig. 4—Temperature at center of journal under various conditions of load and no load

loss. No difference in friction could be expected between the two methods of lubrication, due to the fact that the bearing surfaces were receiving all the oil necessary for successful operation and all other conditions were the same.

Operation in still air and perfect flood lubrication have no practical application in the operation of railroad equipment. It is shown here only to reflect the insulating effect of the waste pack and the effect of air flow against the journal box. Railroad journals to operate at all are immediately subject to air movement. Flood, or bath, lubrication of railroad journals has many mechanical and operating limitations. Due to the fact that railroad journals operate under wide fluctuations of temperature, the insulating effect of waste might be considered an aid to lubrication in its influence on oil viscosity, which would otherwise be controlled by rapid temperature changes, as would exist with flood lubrication. The data reflecting the effect of flood lubrication in still air are to a degree representative of the operating conditions encountered in power-consuming or generating units of a stationary nature.

Effect of Viscosity and Cleanliness of Lubricating Oil on Journal-Box Temperatures

One common factor which influences the amount of heat generated in a journal-box assembly is the viscosity and cleanliness of the lubricating oil. To illustrate this, Fig. 3 reflects the temperature of the center of the journal under no load and without a bearing, comparing the temperature effect of new oils of 45 sec. and 60 sec. viscosity at 210 deg. F., dirty oil as removed from service with a viscosity of 61 sec., and this same oil after cleaning with a viscosity of 54 sec. at 210 deg. F.

The effect of the bearing under load, as a source of increased journal temperature, is not a factor. It will be seen from Fig. 4 that the bearing serves to reduce the operating temperature of the journal by the fact that it aids materially in the dissipation of heat. This is because it provides the principal path for the transfer of the generated heat to the walls of the journal box. This obtains, however, under the condition of clean journal-box packing and with a bearing in proper mechanical condition. Dirty packing or a bearing in improper mechanical condition may be a limiting factor in operation by adding to the heat normally generated in excess above that possible of dissipation through the bearing. The modification of the conventional bearing to compensate further for the effects of temperature and to augment its heat-dissipating capacity has produced outstanding improvements in the actual service operation of bearings.

In Fig. 4 is also shown the temperature of the center of the journal as affected by clean dry waste, and with clean oil-saturated packing, without a bearing or load. Dry packing, or packing with a reduced oil content, approaches the temperature effect of the dry waste shown in proportion to the oil deficiency, which would be further augmented by increasing the dirt content of the packing, as reflected by the combined evidence of Figs. 3 and 4. In actual operation this condition is a source of heating, which is due to the effects of service, producing undersaturated dirty packing.

Conclusion

Obviously, the control of heat sources is the first step in avoiding the limiting effects of excessive temperature rise in the conventional journal-box assembly. The conditions of the waste, the oil, and the bearing are the basic factors in controlling temperature sources. There is no economic substitute for clean journal-box packing properly saturated. The proper conditioning of bearings at the time of initial installation, and their modification in design to compensate for the effects of temperature, increase the factor of dependable operation. The extensive reduction to practice of these fundamental principles by several railroads has amply demonstrated their value.

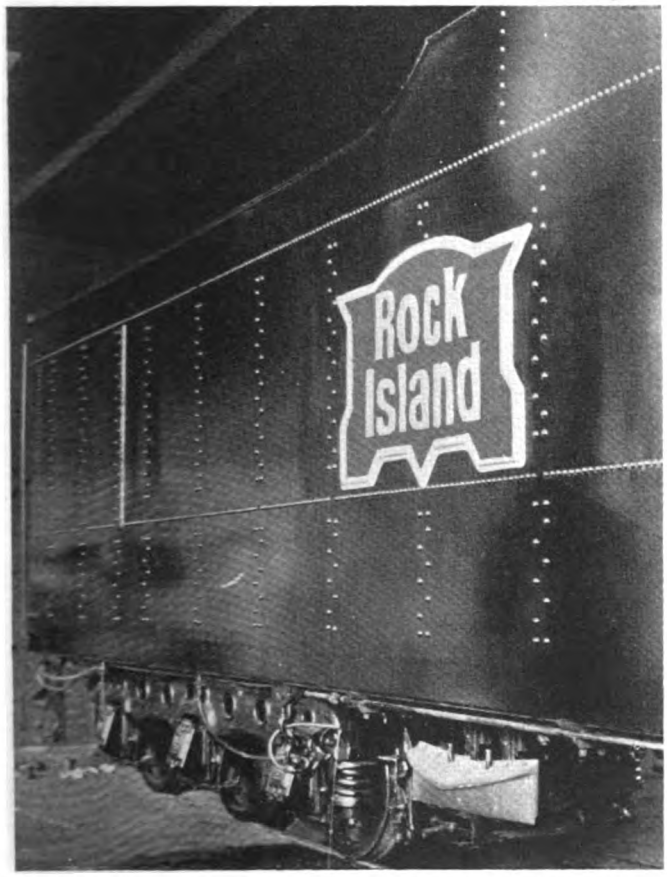
IN THE BACK SHOP AND ENGINEHOUSE

Rock Island Medallion

The medallion, illustrated on the side of a locomotive tender of the Chicago, Rock Island & Pacific, is not only a highly effective and attractive nameplate, but has a number of other rather important advantages. In the first place, from the point of view of durability, this medallion will easily have a service life two or three times that of the ordinary stencilled letters usually applied to locomotive tenders. Then again, the medallion is easily taken from the tender side by simply removing a few cap screws and can be as easily reapplied after any necessary repainting or repair work has been done.

The medallion is made of 16-gage, hot-rolled, annealed, pickled steel. It is 44 in. by 63 in. in size and has especially embossed edges and raised letters. The extreme edges are more deeply embossed than the main background of the medallion which is spaced about $\frac{5}{8}$ in. away from the tender side plate so as to leave room for the thin heads of a suitable number of $\frac{1}{2}$-in. cap screws which are welded to the tender plate. The screw ends project through holes in the medallion which is held firmly in place by $\frac{1}{2}$-in. hex-head brass cap nuts.

The back of the medallion is finished with a durable rust-resisting aluminum enamel, while the face is finished with high-baked Dulux build-up, consisting of a primer, aluminum and red colors, and clear varnish. The cap-screw holes are punched at proper points around the edge just inside the embossed moulding, not being clearly shown in the illustration. The background is red and the edge and letters are finished in aluminum.



Rock Island locomotive tender with embossed medallion which is attractive and durable and may be easily removed or reapplied if necessary

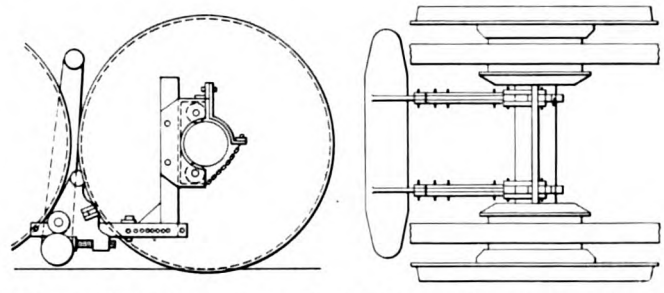
Tire-Turning Tool Has Cutter Control

A method for machining tire flanges and trimming the edges of tires on locomotives without removing the wheels, by the use of a dummy brake head acting as a tool holder, has been used for years, but the lack of control of the cutting tool with this method has limited its use to these operations. The apparatus shown in the diagram has been developed and patented by F. L. Hall, Cincinnati, Ohio and has an arrangement for controlling the cutting tool by utilizing the axle as a center thus making it possible to turn tires to a true circle.

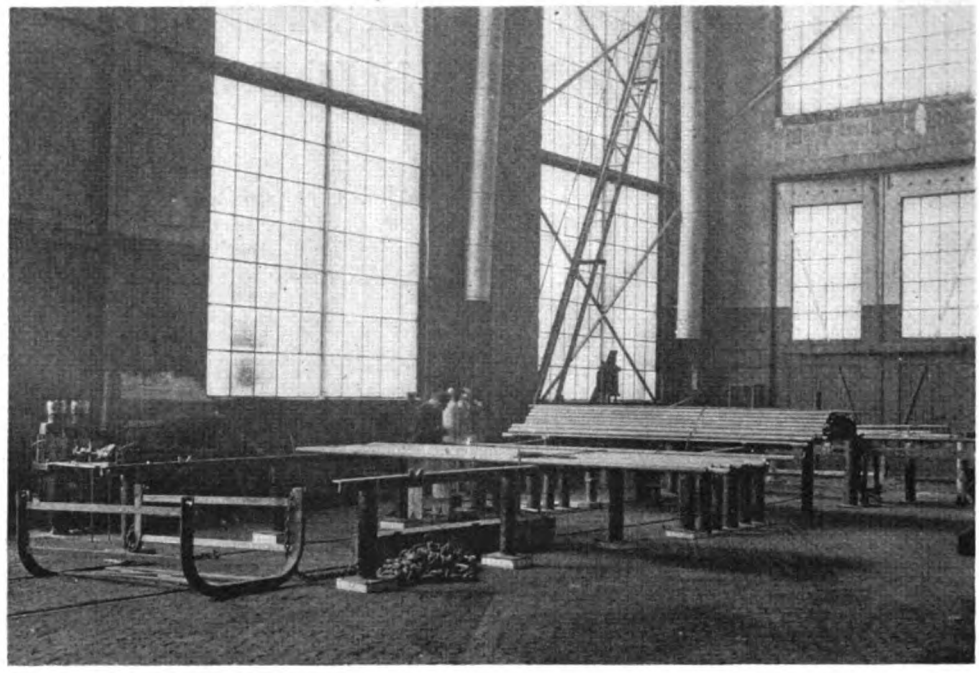
A tool holder with a cutting tool is substituted for the brake head and the brake shoe. Two centering devices are applied to each axle inside the driving wheels with their extensions running back either over or under the brake beam. A brake-beam stop is set in the center of the extension and is adjusted to allow the tool holder to clear the tire when braking pressure is applied. The cutting tool can be located in the tool holder for the depth of cut by setting it with the outside edge of the tire. A round-nose tool can be used for a roughing cut and rough flanging tools are suitable for reducing high flanges, after which a tread-contour tool may be used for the finishing operation.

When braking pressure is applied, the tool becomes engaged with the tire. Then the locomotive is towed by another locomotive or by some other outside source of power. The braking pressure is regulated by adjusting the safety valve on the distributing valve. The brakes are controlled from the ground by means of a rope extending through the cab window.

One hour per pair of driving wheels is required to apply the device while 30 minutes per pair of driving wheels is needed to remove the device and apply the brake heads, although this time may be reduced by an experienced operator having available the proper pit facilities. The tires of over 100 locomotives have been turned with this apparatus at three railroad repair shops. As an example, it is claimed that the cutting time was 12 hours for removing from $\frac{3}{32}$ in. to $\frac{1}{4}$ in. of metal from the tires of five pairs of driving wheels on one locomotive.



A dummy brake head acts as a tool holder and the axle is used as a center in this arrangement for turning tires without dropping the wheels



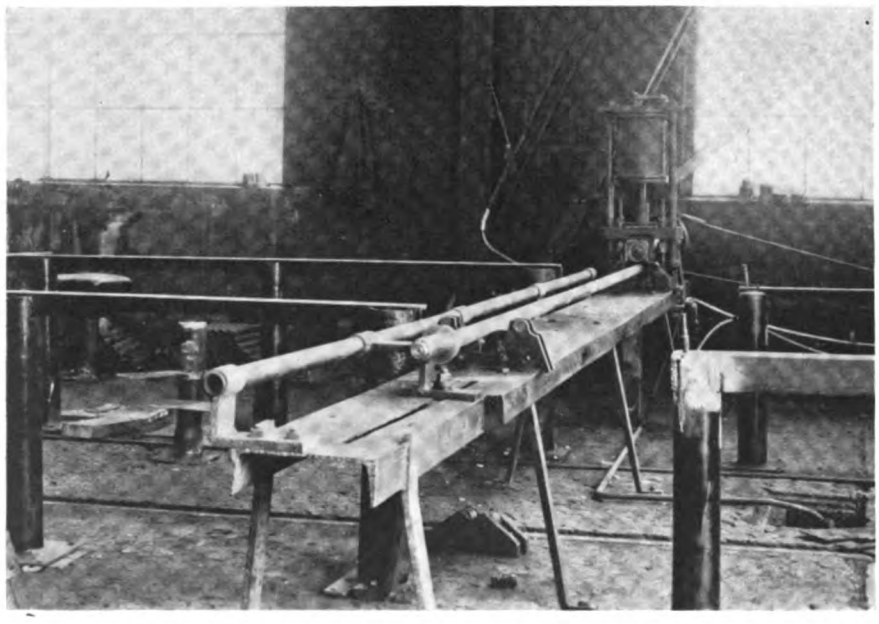
Flue Repair Shop Designed For One-Man Operation

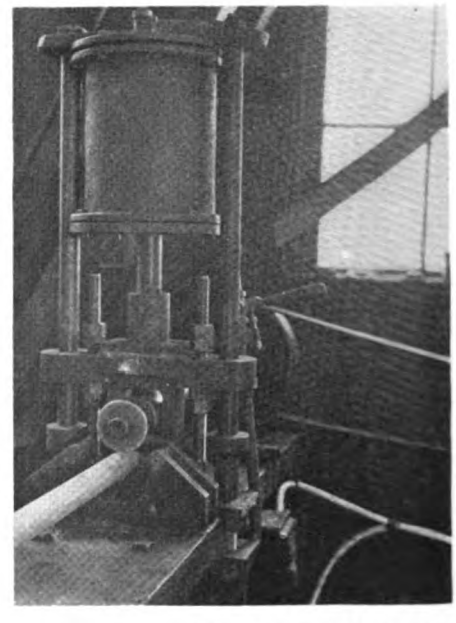
On a small road the problem of efficient and adequate repair facilities is sometimes more difficult to solve than on a large road for the reason that a small volume of work does not readily fit into the commonly accepted ideas of production methods. At Pen Argyl, Pa., the Lehigh & New England has developed its locomotive repair-shop facilities on a basis of providing shop equipment designed for low production costs on a low volume of work. The flue shop described in this article is a typical example of one of the shop departments the equipment of which can be used with a minimum expenditure for labor.

The big-shop supervisor, who thinks in terms of maximum output per day, can appreciate the problem of this shop when it is stated that the requirements for locomotive flues and tubes at the Pen Argyl shop averages about 150 a month under present conditions. (In describing these operations the term flue is hereafter used to include all sizes, from 2 in. to 5 in.) The flue shop, however, when operated with more than one man, has a capacity considerably greater than this if a demand occurs.

Reference to the flue department layout, shown in Fig. 6, will indicate that the work space of the department is about 28 ft. by 55 ft. and that it is designed for one- or two-man operation. The flues, after being re-

Fig. 1 (top of page) shows the general arrangement of the flue shop looking from the end of the sloping runway where the finished flues drop into the cradle—The swedging hammer and heating furnace are seen at the left—An operator is working at the welding position and the top of the cutting machine is silhouetted against the window, above the pile of flues—Fig. 2 (below, left) shows the flue-cutting machine with its adjustable length stop and centering device, the roller support and the cutting head at the far end—Fig. 3 (below, right) is a close-up of the cutting head showing the air cylinder, roller drive and controls for air and electricity.







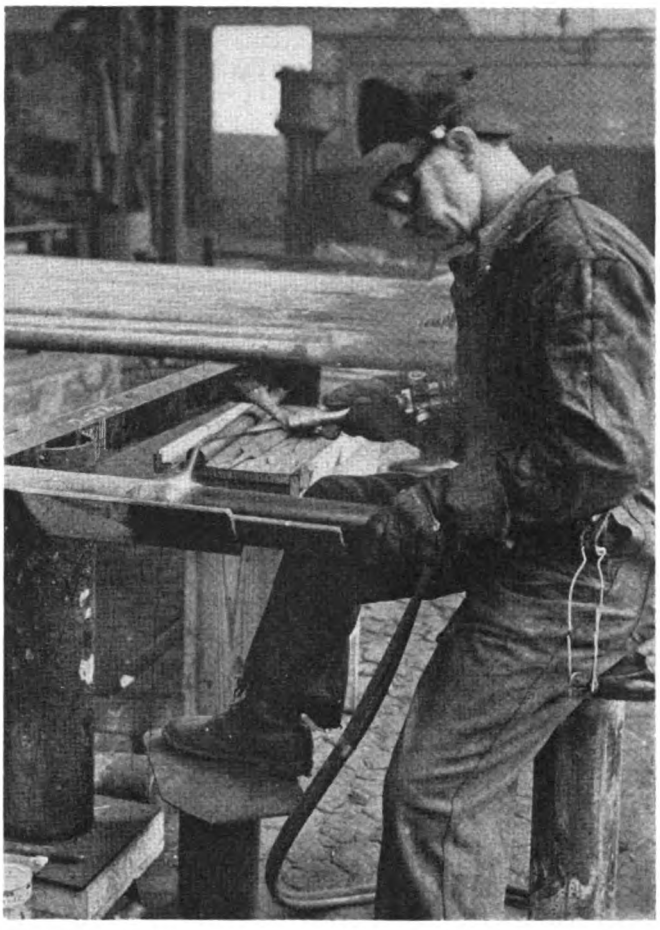


Fig. 4 (above)—The swedging hammer in operation.
Fig. 5 (right)—The flue and the safe end are laid in the angle-iron trough, then welded by the oxy-acetylene process and finally annealed.

moved from the locomotive and cleaned in a rattler outside the shop, are placed in a cradle and brought into the shop through a door adjacent to the flue cutter. They are picked up by an overhead traveling crane and placed on the high end of a 55-ft. double-rail runway which, by means of properly located sloping portions, causes the flues to roll by gravity from one operation position to another until finally they drop into a cradle at the low end of the runway. The total drop of the runway, in its 55-ft. length, is 12 in.

Cleaned, unrepaired flues are picked up from the runway rails and cut off to the proper length. Fig. 1

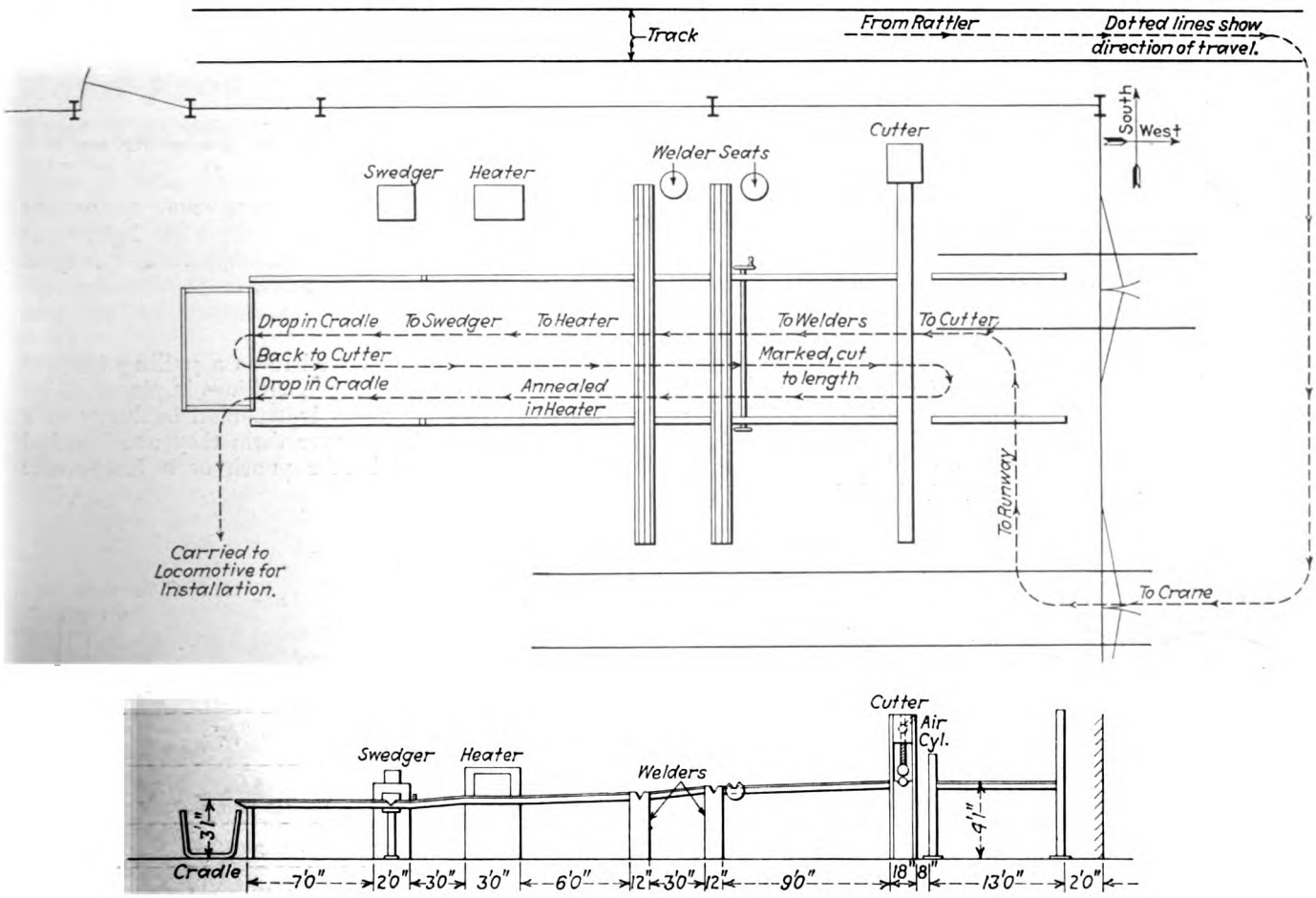


Fig. 6—General arrangement of the flue shop and an elevation of the sloping runway

shows the general arrangement of the repair facilities and Figs. 2 and 3 show the details of the flue-cutting machine. It will be noticed, in Fig. 2, that there is a slot in the inverted-channel table of the cutting machine in which a roller flue-end centering device is secured. This device not only serves to hold the end of the flue in the proper position to assure a cut at right angles to the center line of the flue but may also be adjusted to control the accuracy of the length of the flue.

Fig. 3 is a closer view of the cutter head. The cutting rollers are driven by belt from a motor and pressure on the cutters is applied by means of a pneumatic cylinder. Air and electric controls are located so that they are convenient to the operator. The roller support, which can be seen near the centering device in Fig. 2, simplifies the act of slipping the end of the flue over the mandrel of the centering device.

When the flue is cut it is placed on the sloping runway rails and it rolls down to the safe-end welding position. The drawing shows a flue-stop device at the welding position which had not been installed when the photographs were taken.

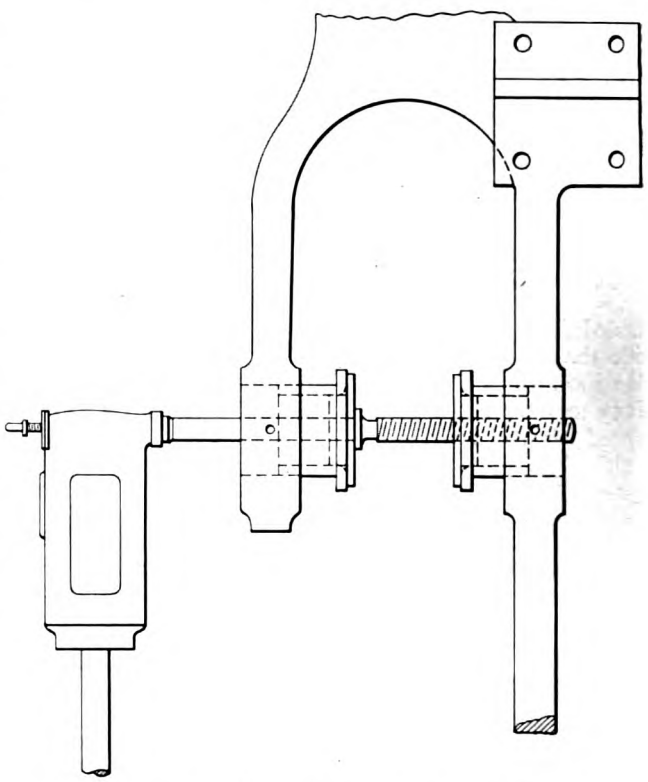
The welding position consists of angle-iron troughs into which the flue drops. Here the safe end is dropped into the trough with the flue and is welded to the flue end by the oxy-acetylene process. After the welding is completed the flue is rolled down the runway to the heating furnace position where the bead of the weld is hammered down and the end swedged. The flues are then dropped into the cradle and returned to the cutting position where they are marked and cut to length. They then roll down the runway to the heating furnace where they are annealed. After the annealing is done the flues again drop into the cradle at the end of the runway and are ready to be transported to the erecting shop for application to the locomotive boiler.

Applying Link Trunnion Bushings

By A. D. Hollis

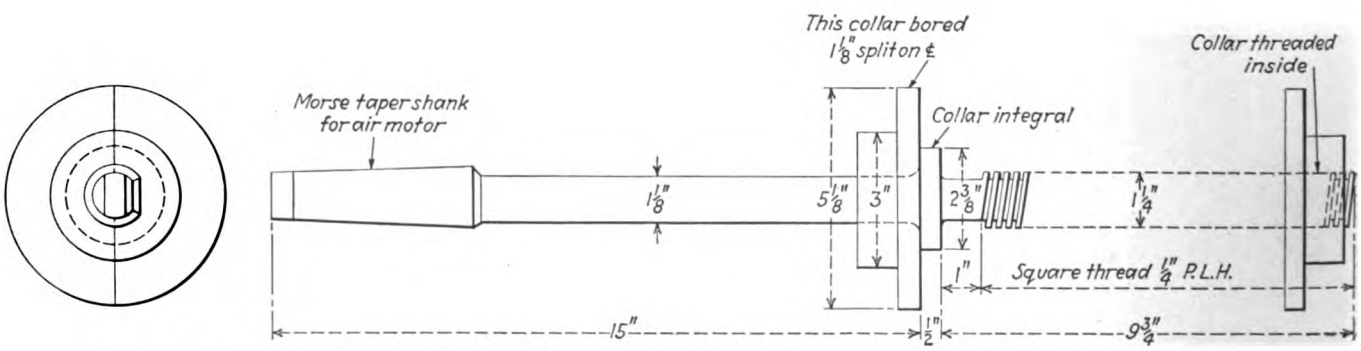
A convenient device which utilizes screw action and the power of an air motor to apply link-trunnion bushings in Walschaert valve-gear brackets is shown in one of the drawings and the use of the tool in the second drawing. The device is unique in that it forces in both bushings at the same time and utilizes the convenient type of close-quarter generally employed for reaming in railroad shops. When the power of the motor is applied the bar turns in a clockwise direction and the ¼-in. left-lead screw backs out of the collar at the right which is internally threaded like a nut. This action forces the bushings in place. The collars are shouldered to fit freely inside of the bushings used on all locomotives equipped with Walschaert valve gear. The collar at the left is bored a free fit on the 1⅛-in. portion of the bar and is split on the center line so that it may be removed in two halves.

The use of this device tends to spread the two members of the link bracket apart slightly, so, after placing a good strain on the bracket, the motor is shut off and the bracket struck on the outside with a copper sledge hammer. In this manner the bushings may be pressed in without spreading the bracket. On some light types of link brackets that are not well supported it may be desirable to use a bolt and clamps so the bracket will not be spread enough to take a permanent set and thus be thrown out of alignment.



Link trunnion bushing applicator set up ready for use

Although sometimes referred to as a pulling bar, the threaded bar actually pushes the bushings in place. With this tool it is possible to apply trunnion bushings in a very few minutes. To remove them they are knocked out with a sledge and handle punch or a long-stroke hammer.



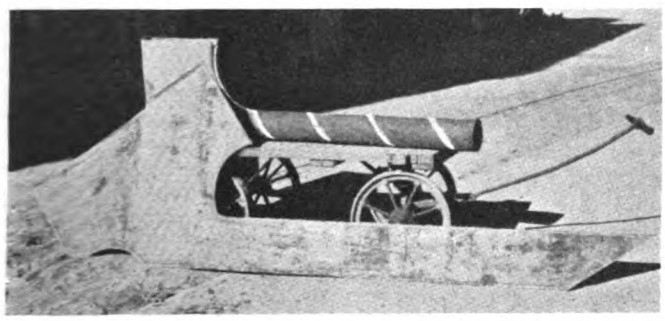
Detailed dimensions of a device used in applying Walschaert link trunnion bushings by screw pressure

Syphon Patch With a Spiral Seam*

The completed syphon patch, shown on the truck in the illustration, was fabricated from a sheet of a shape similar to the sheet which is leaning against the truck. Four syphon patches of this type were applied to syphons of two locomotives on a western railroad.

This patch was designed and constructed with a spiral seam because of the lack of equipment for making a patch of this size with a straight seam running the length of the patch, a distance of 84 in. A sheet was cut to the shape of the developed surface of that part of the syphon which the patch replaced. It was formed by rolling and then welded along the spiral seam.

* An entry in the prize competition on boiler patches, announced in the March, 1939, issue. The names of the winners were published in the August, 1939, issue.

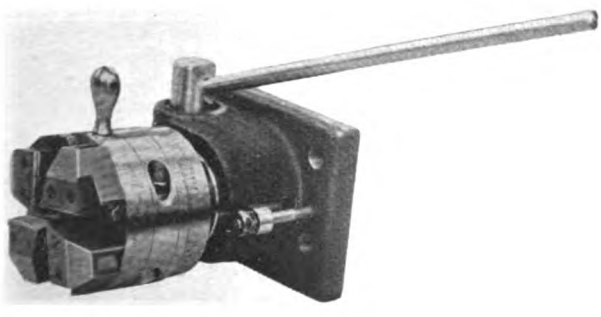


The completed syphon patch is shown on the truck—The shape of the patch before rolling is indicated by the sheet leaning against the truck

Hand-Feed Adapter For Turret-Lathe Head

When using a die head on a heavy-duty turret lathe, a mechanism of some type is recommended which will enable the operator to relieve the head of the load of the heavy turret and carriage. A sliding adapter designed by the Landis Machine Co., Waynesboro, Pa., for use with Landmatic heads not only permits of a floating action for the die head, but also provides a gear mechanism for starting the die head onto the work by hand.

The usual type of sliding adapter provides a floating action which permits the operator to advance the turret independent of the head, but no provision is made for starting the die head onto the work other than by means of the rack and gear which are ordinarily used to advance the carriage. The forward or thread-starting movement of the die head in the Landis adapter is accomplished through an intermediate gear mechanism within the adapter. A rack gear is milled axially along the peripheral surface of a bushing to which the die head shank is fitted. A pinion gear, whose teeth engage the rack gear on the bushing, is fitted with a long handle which is used to actuate the movement of the bushing.

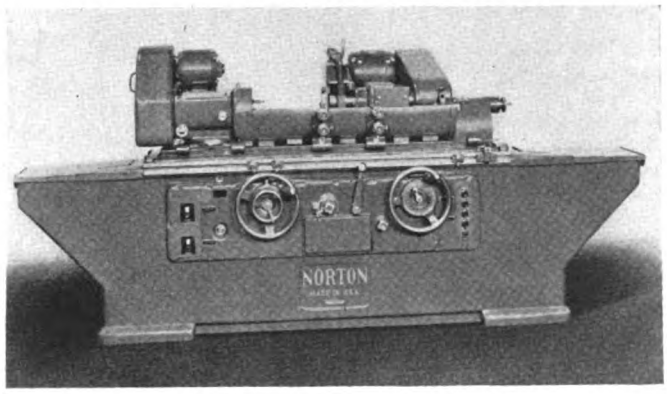


Landis hand-feed adapter for Landmatic heads

Universal Machine for External and Internal Grinding

A universal grinder, which performs both external and internal grinding, has been designed by the Norton Company, Worcester, Mass. This machine, known as the type LC Multipurpose, has a swing of 12 in. and is built in 24, 36, 48, and 72-in. lengths. It requires a floor space about 5 ft. in width and a length of from 9½ ft. for the shortest machine to 17½ ft. for the longest machine.

The base is a ribbed single casting with the reservoirs for the coolant and the oil for hydraulic operation cast as an integral part. The table can be propelled hydraulically or by hand through a two-speed arrangement, thus making it possible to move the table quickly into position or more slowly for shoulder grinding or similar operations. A single lever disengages the rapid hand traverse and engages the slow traverse. An electric dwell control for the hydraulic traverse mechanism is furnished.



The Norton 12-in. type LC Multipurpose grinder with the splash guards in place

The grinder has two ranges of feed, either of which may be selected by pushing in or pulling out a single knob. Each hole in the index is equivalent to a work diameter reduction of .004 in. in the fast range and .0001 in. in the slow range. The headstock is of the universal type and is driven by either a ½-hp. a.c. constant-speed motor or by a variable-speed d.c. motor. When an a.c. motor is furnished, four work speeds ranging from 65 to 260 r.p.m. are obtained by cone-type V-pulleys. A push button controls the work speed.

Both live-spindle and dead-center operations can be performed, the change from one type of drive to the other requires only the adjustment of a knob on the front of the headstock. The base is graduated and can be set at any desired angle either side of the zero position. All bearings are pressure lubricated. The final drive to the face plate is by a chain.

High Spots in

Railway Affairs . . .

How People Travel In This Country

The Interstate Commerce Commission, in its annual report to Congress, makes some interesting observations as to the division of passenger traffic in this country in 1938 between the various forms of transport. Leaving out of consideration urban traffic, it is estimated that the private automobiles carried 84.95 per cent of the intercity travel. This is a long step from the horse and buggy days. The steam and electric railways carried 8.44 per cent; the busses, 5.87 per cent; rail and waterways, .56; and the air carriers, .18 per cent. The passenger-miles by air amounted to about 6 per cent of the pullman travel. If the private automobile is eliminated from the calculations, and only the common carriers are considered, then the railroads accounted for 56.1 per cent of the passenger-miles in 1938, the busses, 3.90 per cent; the rail and waterways, 3.7 per cent; and the air lines, 1.2 per cent.

Taxes, And More Taxes

The railway stockholders have taken a severe licking all during the '30's. Some of them, preferred as well as common, have been entirely wiped out in the reorganizations—and even the bondholders have not gotten off any too well. The governments, however,—federal, state, county and municipal—have had a generous slice of the railway's earnings. The Railway Age points out that, "for every dollar of net income earned by the railways for their stockholders in the nine years ending with 1939 their taxes amounted to $12.38. During this period taxes averaged more than $295,000,000 annually, while net income averaged less than $24,000,000. The total taxes paid in the years 1931-1939, inclusive, amounted to $2,656,056,000; net income earned in these same years was $214,564,000. Thus the pay-off of the tax collector, as compared with the owner, was more than twelve to one, with the tax collector on the long end of the transaction."

"Orphan Annie"

Nobody in official Washington seems to be greatly concerned about relief to the railroads in the form of more equitable regulation. Bills, designated as S. 2009, somewhat similar in contents, but quite different in form, were passed by both the Senate and the House before adjournment last summer. They were sent to conference and the expectation was that the conferences would get together in the fall or early winter and have a report ready to present early in the present session. They did not do so, and it is not apparent at this writing just when they expect to "get down to brass tacks." The conference committee is scheduled to hold a meeting February 1. The President's message was concerned mostly with foreign affairs and national defense, although in enumerating "other items of great public interest" he did list "the freeing of large areas from restricted transportation discrimination," whatever that may mean.

President Roosevelt On Waterway Tolls

"Uncle Sam," contrary to New England tradition, has been quite a spendthrift in these recent years. Apparently he is beginning to get worried about the day of reckoning. Said President Roosevelt in his recent budget message to Congress: "I have always believed that many facilities made available to our citizens by the government should be paid for, at least in part, by those who use them. * * * A start on this policy has been made. In such a way a substantial part of the annual cost of maintenance of roads, trails, and grounds in forests and parks will come back to the Treasury and reduce the annual cost of government. Another example is the $50,000,000 the government spends annually in the maintenance of dredged channels, buoys, lighthouses, lifesaving stations, and so forth. It would seem reasonable that some portion of these annual expenditures should come back in the form of small fees from the users of our lakes, channels, harbors, and coasts."

The Struggle For Freight Business

The jurisdiction and operations of the Interstate Commerce Commission have been considerably broadened in recent years because of the rapid development of intercity common-carriers other than the railroads. This is reflected in its annual reports. In the current one, recently presented to Congress, it attempts to give an overall statistical picture of the operations of these carriers, although it freely admits that its estimates may have a considerable margin of error. Of the intercity traffic on a ton-mile basis the railroads carried 62.82 per cent in 1938; the inland waterways, 14.33 per cent; the oil pipe lines, 14.26 per cent (it was only 11.97 per cent in 1937); the private intercity trucks, 4.83 per cent; and the intercity tracks for lines, 3.76 per cent. The ton-miles on inland waterways were much lower in 1938 than in 1937, because of a heavy falling off in ore tonnage on the Great Lakes. The railways are certainly faced with plenty of competition.

Good Year for Scrap

War—whether declared or not—always seems to have a favorable effect upon the scrap market. Much scrap was shipped from this country to Japan in the last two years, and there has been a large demand for it in the United States since the steel industry speeded up its production in recent months. It is estimated that last year about 70 per cent of the scrap went into the production of new steel, 20 per cent into castings and 10 per cent into miscellaneous uses. The Railway Age estimates that in 1939 the railroads sold about $55,000,000 of iron and steel scrap, in addition to which they received approximately $25,000,000 in freight revenue for transporting scrap. This revenue compared to about $14,000,000 in 1938; neither year, however, approached anywhere near the traffic revenue from scrap in 1937 of $34,060,000.

Returning to Sanity

It is rather interesting in these days to wander about behind the scenes in Washington and study the reactions of those in high places. Whatever the cases may be—the approaching election, the war clouds hanging low over the world, a colossal and still mounting public debt, New Deal policies on the defensive, or what not—there is quite a different atmosphere than that which existed a couple of years ago. Indeed, there has been a steady shifting for many months, away from cocksure and dogmatic statements, all along the line. Exponents of radical measures, who formerly spoke in no uncertain tones of conviction, are much less outspoken today, and even admit that some mistakes have been made—an almost unheard-of and unthinkable attitude on their part a few years ago. The "wise boys on the Hill"—members of Congress—who have been in touch with their constituents back home reflect this swing away from the left toward the center in even more decided fashion. One can almost imagine them saying: "We have had our fling. Let's get down to sound common sense and see what we can conserve from the wreckage, before it is too late. Many good things have been started, but let's separate them from the follies and discard the latter."

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Among the Clubs and Associations

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Meeting February 12, 8:00 p. m., LaSalle Hotel, Chicago. Speaker: J. E. Mehan, assistant to superintendent of car department, Chicago, Milwaukee, St. Paul & Pacific. Subject: Discussion of changes in the A. A. R. Rules of Interchange.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—Meeting March 21, 10 a. m., Ansley Hotel, Atlanta Ga. Motion picture of the Tennessee Coal, Iron & Railroad Company on the "Making and Shaping of Steel."

NORTHWEST CAR MEN'S ASSOCIATION.—Meeting February 5, St. Paul, Minn. Speaker: L. R. Kassick, general foreman, Soo Line, Minneapolis, Minn. Subject: Proposed changes in A. A. R. rules as presented by A. A. R. committee.

TORONTO RAILWAY CLUB.—Meeting February 26, 7:45 p. m., Royal York Hotel, Toronto, Ont. Speaker: T. V. Buckwalter, vice-president, Timken Roller Bearing Company, Canton, Ohio. Subject: Steam Locomotive Slipping Tests and Photoelastic Study of Stresses on Railway Axles. Motion pictures.

CENTRAL RAILWAY CLUB OF BUFFALO.—Meeting, February 8, Hotel Statler, Buffalo, N. Y. Speaker: L. W. Horning, regional director, Association of American Railroads, New York. Subject: New Frontiers in the Railroad Industry. Central Railway Club chorus.

RAILWAY CLUB OF PITTSBURGH.—Meeting January 25, Fort Pitt Hotel, Pittsburgh, Pa. Speaker: Dr. Harvey Bartle, chief medical examiner, Pennsylvania, Philadelphia, Pa. Subject: Medical Side of the Railroad Industry and Its Management.

CANADIAN RAILWAY CLUB.—Meeting, February 12, 8:15 p. m., Rose Room, Windsor Hotel, Montreal, Que. Speaker: A. Reyburn, foundry superintendent, Canadian National. Subject Mechanization of Foundry. Illustrated.

NEW ENGLAND RAILROAD CLUB.—Meeting, 6:30 p. m., February 13, Hotel Touraine, Boston, Mass. Speaker: E. D. Campbell, general mechanical engineer, American Car and Foundry Company. Subject: Riveted and Welded Construction of Freight and Passenger Cars; illustrated by lantern slides. Dinner prior to address.

Club Papers

Diesel Switchers Show Savings

Pacific Railway Club.—At the September meeting of the Pacific Railway Club at Los Angeles, Calif., some specific information regarding the performance of Diesel locomotives in switching service was presented by M. D. Raymond, Pacific Coast manager of the American Locomotive Company. ¶Any new type of motive power, said Mr. Raymond, must justify itself by showing a net return on the investment. That the Diesel switching locomotive can justify itself on this basis can easily be substantiated by a careful study of some 350 odd installations now operating on American railroads. These savings can be divided into two classes: first, the direct savings in operation against the present-day operation of steam switchers, and second, the indirect savings. ¶The direct savings are based on the differences in cost between steam and Diesel operation, considering the following items: wages, fuel, water, lubrication, maintenance, enginehouse, and miscellaneous. The first item covering wages of the engineman and fireman will be the same in both cases, whether Diesel or steam. The principal savings come from fuel, water, maintenance, and enginehouse expense, the savings in enginehouse expense being mainly in boiler washing, hostling, fueling, and fire-cleaning. Based on figures obtained from a great many railroads, this saving runs all the way from $1.75 to $2.50 per operating hour. Taking the minimum figure of $1.75 an hour, and considering an average continuous switching operation requiring 7,200 hours per year of service, it means that there is a direct saving of $12,600 per year by the use of Diesel switching power. ¶The indirect saving depends greatly upon the individual case and whether or not it is possible to abandon coal-dock and ashpit facilities, and boiler-washing equipment. Full benefit, therefore, cannot be derived from long engine runs unless the steam switchers are entirely replaced at these intermediate terminals with some other form of power which does not require the use of the facilities mentioned. Since the Diesel does not require any of the special facilities demanded by the steam switcher, it is ideally suited for this purpose and its installation at these terminals will add materially to its direct savings. ¶A true picture of the economic side involves consideration of the cost of Diesel locomotives. A price reduction averaging about 10 per cent has been effected in the past year. So-called stock designs can be produced in quantities resulting in substantial reductions in manufacturing costs which in turn can be passed along to the railroads. This work has progressed to such an extent now that the added cost of a modern Diesel switcher is only approximately 1.4 times the cost of an equivalent steam switching locomotive. Since the Diesel switcher will replace 1.4 steam switchers, the total investment for new power would be no greater for Diesel switchers than it would be if new steam locomotives were purchased. ¶From the point of view of direct savings alone, it can be readily seen that the Diesel switching locomotive will pay for itself in a maximum period of from five to seven years. In fact, there are many instances where these Diesel units have paid for themselves in three years' time. ¶In discussing Mr. Raymond's paper, Lee Pearson, road foreman of engines of the Atchison, Topeka & Santa Fe at San Bernardino, Calif., said that too many cars are frequently handled in switching movements and the resultant run of slack in high-speed switching, with either Diesel or steam power, causes damage to cars and lading which may not be apparent at the time. Road handling is also to blame for some damage, but the preponderance of the damage is done in yard handling. ¶In operating switch locomotives, therefore, whether Diesel or steam, necessary care must be taken to control slack. Enginemen are instructed, in operating their locomotives, regardless of the kind of power being used, to apply the brakes lightly when a stop signal is given and let the slack run as gently as it will. After they feel the "tug" of the tonnage in the cut they can then apply the brakes to their full value and average good handling will result. ¶Mr. Pearson said that the necessary power to turn the traction motors assists considerably in retarding the speed while drifting up to a cut of cars, this retardation being much more pronounced with a Diesel switcher than would be the case with a steam switching locomotive. However, a few days of experience in operating Diesel switching power usually enables the engineman, with one operation of his throttle, to come up to a cut of cars at the desired speed and make a coupling without any appreciable or, at least, any objectionable shock. ¶The rough handling mentioned is particularly obnoxious when handling a cut of occupied passenger cars, but, in Mr. Pearson's opinion, only a week or ten days of experience is required for the average engineman to lose his fear of handling the Diesel switching locomotive and become very proficient in its operation and handling. He said that wonderful results have been secured in Diesel switching service when the operation and handling are fully understood, and that substantially less rough handling will unquestionably be brought about in yards by the more general adoption of Diesel switching power.

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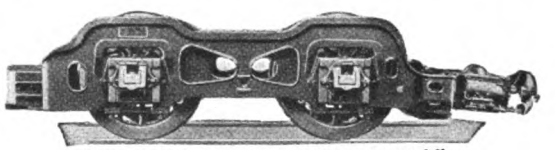
THE rated draw bar pull of a locomotive is the average of the constantly varying effort exerted throughout one revolution of the driving wheels. Such a rating considers that the locomotive is moving and is by no means a correct indication of the power exerted in starting from a state of rest.

Starting power depends entirely upon the exact position of the cranks at the instant of starting. Crank position not only controls the leverage between piston and driving wheel but also determines whether or not both valves are open for admission of steam to the cylinders.

The above chart illustrates a typical starting draw bar pull curve for a modern two-cylinder locomotive with Booster. Curve "A" shows the starting draw bar pull of the main locomotive for all crank positions. Curve "B" represents the combined starting draw bar pull of the locomotive and Booster, the shaded area between curves "A" and "B" being the starting draw bar pull added by the Booster. Curve "C" in the lower portion of the chart shows in percent the increased power with the Booster for all crank positions.

The chart also clearly shows that for about 216° or 60.4% of the crank circle the power of only one cylinder is available for starting. This means that most starts would be made with one cylinder, or slack would have to be taken to place the cranks in a more favorable position, if Booster power is not used.

It will also be observed that at four points on the crank circle the starting effort of the locomotive reaches a minimum at which approximately one-third of the rated draw bar pull is exerted. It is at these low points that Booster power is most effective, in some cases adding as much as 67% to the starting draw bar pull of the locomotive, or the equivalent of 2 additional driving axles.

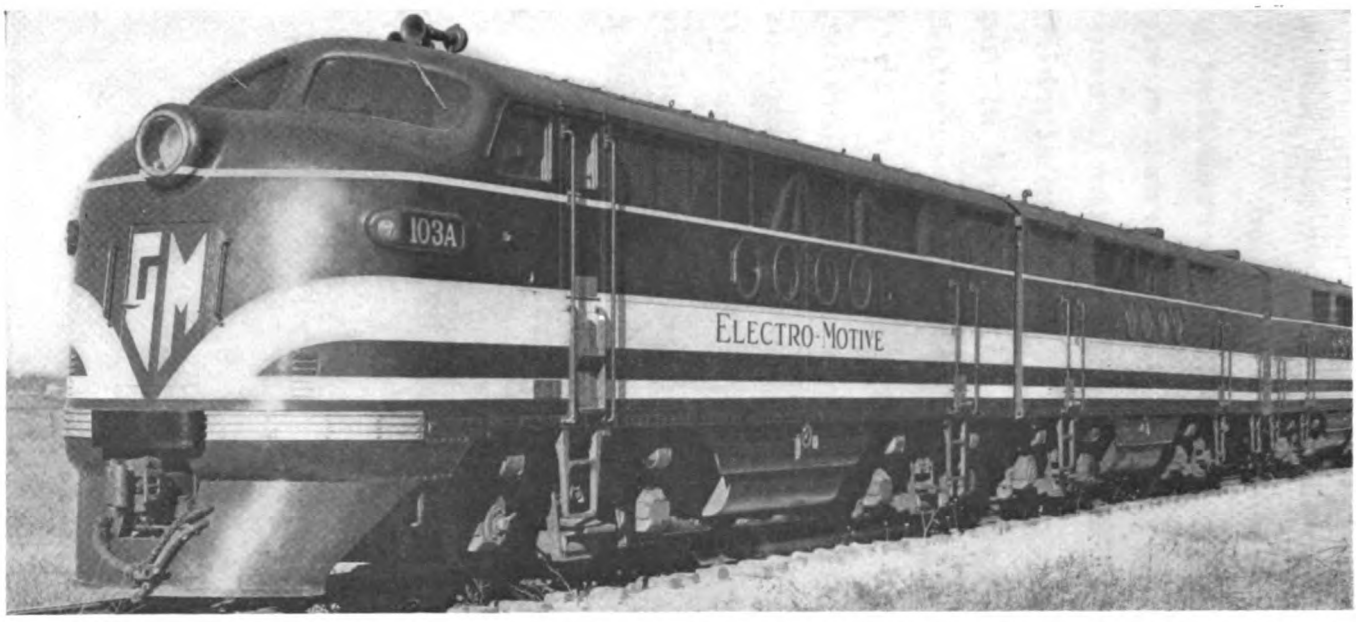


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Two Electro-Motive Diesel-electric freight locomotives coupled to form a 5,400-hp. unit—Each locomotive consists of two units each containing a 16-cylinder, 1,350-hp. General Motors Diesel engine—Now being tested on the Atchison, Topeka & Santa Fe

NEWS

Lawford H. Fry to Lecture at Franklin Institute

LAWFORD H. FRY, railway engineer, Edgewater Steel Company, Pittsburgh, Pa., will lecture on The Steam Locomotive, Its Development and Present Position in Railroad Transportation, at the Franklin Institute, Philadelphia, Pa., on February 21.

Arch-Bar Truck Rule Modifications

ACCORDING to Circular D. V.—972, recently issued by the Association of American Railroads, Mechanical division, certain modifications have been made in the interchange rule which prohibit acceptance from owners of freight cars equipped with arch-bar trucks after December 31, 1939.

Effective January 1, 1940, a note is added to Par. (4), Sec. (t), Rule 3, as follows: "(t-4) Trucks, with arch bars, prohibited, on and after January 1, 1940, under all cars. From Owners.

"Note.—The movement of cars equipped with arch-bar trucks must be confined to owner's rails, except that they are acceptable in interchange from owner for loading or for unloading within the same terminal switching district in which the interchange occurs, provided that no road haul is involved in such movement, and provided that cars so interchanged will be immediately returned to owner's rails when loading or unloading is accomplished.

"Cars equipped with arch-bar trucks are acceptable for movement between plants located in the same switching district, provided no road haul is involved."

Effective January 1, 1940, the second note following Par. (2), Sec. (w) Rule 3, is modified to read as follows:

"Note.—Industrial or other cars not intended for interchange service, when moving on their own wheels, may be accepted in interchange in their initial movement from manufacturer to destination (or seaboard) without meeting the requirements of Sec. (a), Par. (1), in so far as the retaining valve and A. A. R. standard triple valve are concerned, second paragraph of Sec. (b) for No. 2 A. A. R. brake beams, first, second and seventh paragraphs of Sec. (c), third paragraph of Sec. (s), paragraphs (1), (2-a), (2-b) and (4) of Sec. (t) and Specifications for Tank Cars. To each side of such cars a card shall be attached by shippers, reading as follows: 'Industrial or Export Car shipped in accordance with A. A. R. Rule 3. Signed.....Shipper.'"

Industrial Progress Award Program

THE James F. Lincoln Arc Welding Foundation has announced a 2½-year program of scientific study for improving designs, manufacture, fabrication, construction, and maintenance of all types of machines, building, structures and products which will culminate on June 1, 1942, in the payment of $200,000 in awards, ranging from $13,700 for first prize down to $100. Locomotives, freight cars, passenger cars, and locomotive and car parts are in Classification C, Divisions C-1 to C-4, inclusive.

Inquiries for further information concerning the program should be addressed to the Secretary, The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Winterrowd Elected to Board of Managers of Franklin Institute

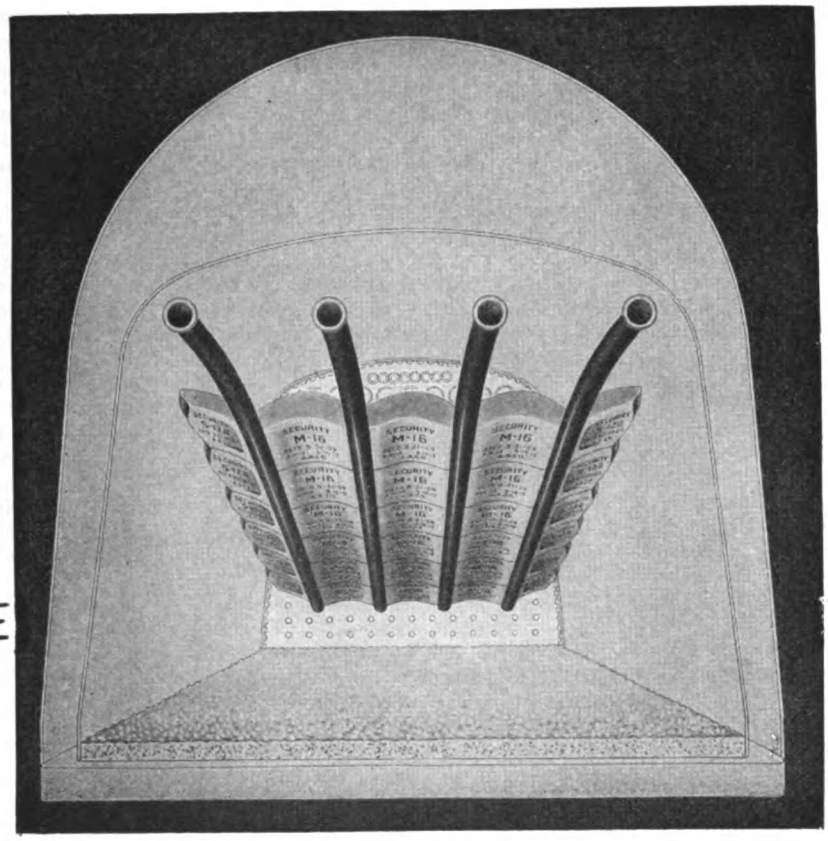
W. H. WINTERROWD, vice-president in charge of operations of The Baldwin Locomotive Works, has been elected a member of the Board of Managers of The Franklin Institute, Philadelphia, Pa., a representative group of industrial, financial, and educational leaders who direct its affairs. The Institute is devoted to the advancement of science and the promotion of the mechanic arts.

Annual Report of the Bureau of Safety

MAKING his last annual report as director of the Bureau of Safety, Interstate Commerce Commissioner William J. Patterson reviewed the fiscal year ended June 30, 1939, in a 52-page pamphlet setting forth in the usual form results of inspection of safety-appliance equipment on railroads, together with information concerning the hours-of-service records of employees, installations of signals, investigation of accidents, and other activities of the Bureau. Mr. Patterson who had been director of the Bureau of Safety since March, 1934, became a member of the commission by appointment from President Roosevelt last July; and Shirley N. Mills succeeded him as head of the Bureau.

During the year under review a total of 1,144,168 cars and locomotives was inspected, 29,232 or 2.55 per cent were found defective, as compared with 2.41 per cent defective out of the 1,213,081 inspected in 1937-38. The percentage defective in 1938-39 (the above-mentioned 2.55 per cent)

(Continued on next left-hand page)



ANYTHING

less than a complete arch

IS FALSE ECONOMY

To let the desire for reduced inventory result in a locomotive leaving any roundhouse without a full set of Arch Brick is poor economy. » » » Even a single missing Arch Brick will soon waste many times its cost in fuel and in locomotive efficiency. » » » To spend the fuel dollar efficiently, every locomotive Arch must be maintained 100%. » » » Be sure your stocks on hand are ample to provide fully for all locomotive requirements, so that locomotive efficiency may be maintained.

There's More to SECURITY ARCHES Than Just Brick

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.

Locomotive Combustion Specialists

was greater than in any of the preceding nine years, and compares with a post-1930 low of 1.83 per cent in 1931-32.

Air-brake tests were made on 2,508 trains, consisting of 110,467 cars, prepared for departure from terminals; air brakes were found operative on 110,390, or 99.93 per cent, of these cars. This percentage, however, was attained only after 753 cars having defective or inoperative brakes had been set out, and repairs had been made to the brakes of 700 other cars in the trains. According to the report, it was found necessary to repair the brakes or set out an average of nearly three cars for every five trains. Tests on 805 trains arriving at terminals with 39,979 cars showed that the air brakes were operative on 98.55 per cent of the cars—the cars with inoperative brakes averaging slightly over two for every three trains tested.

Commenting on the program for equipping cars with AB brakes, Mr. Patterson reports that improvement is not being effected as scheduled; that "appropriate action to expedite this improvement is required." During the year under review 43,234 additional cars were equipped, bringing the total to 13.64 per cent of the number of cars used in interchange service. This 13.64 per cent is a composite figure, representing 14.47 per cent of the railroad-owned cars and 8.27 per cent of those owned by private car lines. Meanwhile 4½ years or 45 per cent of the 10-year-period allotted for making the improvement had elapsed on last June 30; and "a considerable number of car owners have not even started . . ., the equipped cars . . . having been reported by only 88 railroads and 77 private car lines." The Bureau next observes that further tests are required for final determination of the proper cleaning period for AB brake equipment, now fixed tentatively at 36 months by the Association of American Railroads.

Co-operative action with the A. A. R., referred to in the previous report, has been continued for the purpose of improving the condition of couplers, draft gears, and their attachments and supports, with a view to eliminating or reducing the parting of trains due to slip-over of knuckles "which at prevailing high speeds with long trains is a serious hazard in operation." Note is taken of the fact that the deadline date for the elimination from interchange service of cars equipped with arch-bar trucks was extended by the A. A. R. to last December 31 with a definite provision that there would be no further extension. Also mention is made of the Bureau's co-operation with A. A. R. in developing revised specifications for the structural design of new passenger-train cars and "the importance of providing braking methods and apparatus to control high-speed trains properly."

"Considerable activity," the report goes on, "is evident in the development of new brake designs of disk, rotor and drum types which do not utilize treads of car wheels as braking surfaces, as well as further improvements in valvular mechanisms, devices to prevent sliding of wheels and means for sanding rails under all wheels simultaneously with brake applications, in order to provide the basic essentials of adequate retardation rate and rail-wheel adhesion. As yet these experiments and tests have not proceeded far enough to warrant any conclusions as to the relative efficiency of proposed systems of this type as compared with brake systems now in service." The Bureau's observations of these tests will continue as will its scrutiny of the results of last year's A. A. R. tests of trucks designed for high-speed freight service.

The section of the report on the Bureau's accident-investigation work reveals that during the 1938-39 fiscal year the commission received reports of 1,298 collisions and 3,121 derailments; in these 133 persons were killed and 828 injured, as compared with 195 killed and 1,115 injured in 1937-38's 1,469 collisions and 3,823 derailments.

Equipment Purchasing and Modernization Programs

Baltimore & Ohio.—The Baltimore & Ohio has asked the Interstate Commerce Commission to approve a plan whereby it would issue and sell to the Reconstruction Finance Corporation $5,330,000 of 2½ per cent equipment trust certificates, maturing in 10 equal annual installments of $533,000 on February 1, in each of the years from 1941 to 1950, inclusive. The proceeds would be used in part payment of the purchase price of 500 steel box cars, 500 gondola cars, 1000 steel hopper cars, and 100 steel hopper cars for cement loading, costing a total of $5,929,000. Orders for most of this equipment were reported in the November, 1939, issue of the *Railway Mechanical Engineer*.

Missouri Pacific.—The 1940 budget for the Missouri Pacific, calling for expenditures of $10,888,000 for improvements and betterments has been approved by the federal district court. Of this sum, $1,431,490 was authorized last October for the purchase of new rails and fastenings. Among the items in the budget are $1,350,000 for the purchase of new rolling stock; $250,000 for the purchase of a three-unit streamline train for operation between Memphis, Tenn., and Lake Village, Ark.; $580,000 for the purchase of 11 Diesel-electric switching locomotives; $570,000 for the purchase of 200 stock cars for the Texas lines; $390,580 for the rebuilding of four passenger locomotives and two freight locomotives; and several hundred thousand dollars for general repairs to 1,975 freight cars, and the installation of new type brakes on 1,210 freight cars. Sums are also included in the budget for the laying of new rail, station improvements, traffic control, and signal work.

The New York Central.—The New York Central contemplates buying a number of new passenger cars and plans to rebuild a number of its present cars.

Northern Pacific.—The Northern Pacific will purchase seven Diesel-electric switching locomotives. Three 1,000-hp. locomotives will be assigned to Northtown yards, Minneapolis, Minn., two 660-hp. to Seattle, Wash., and one each of 660-hp. to Spokane, Wash., and Tacoma. These locomotives are a part of the road's 1940 rail and equipment purchase program which will total $8,500,000.

St. Louis-San Francisco.—The 1940 budget of the St. Louis-San Francisco provides for the expenditure of $3,444,010 for mechanical and roadway improvements. The mechanical improvements include the converting and repairing of locomotives, $746,204; the rebuilding and remodeling of freight cars, $419,499; the rebuilding and remodeling of passenger cars, $198,778; and new shop machinery and equipment, $22,441. Total mechanical expenses for the year will be $1,386,922, not including $51,163 for Texas lines.

Southern Railway.—This company is undertaking to modernize in its own shops, 14 all-steel passenger coaches, which will be assigned to service between Washington,

Orders and Inquiries for New Equipment Placed Since the Closing of the January Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Locomotive	Builder
Chilean State Railways	10	4-8-2	American Locomotive Company

LOCOMOTIVE INQUIRIES

Road	No. of Locos.	Type of Locomotive	Builder
Terminal R. R. of St. Louis	5	0-8-0	.....

FREIGHT CAR ORDERS

Road	No. of Cars	Type of Car	Builder
General Chemical Co.	75	Tank	Gen. American Trans. Corp.
Lehigh Valley	24	Caboose	Company Shops
Minneapolis & St. Louis	10	Hopper	Gen. American Trans. Corp.
Norfolk & Western	100*	Box	Greenville Steel Car Co.

PASSENGER CAR ORDERS

Road	No. of Cars	Type of Car	Builder
C. B. & Q.	5†	.....	Edw. G. Budd Mfg. Co.

* One-half to be equipped with auto loaders.

† Tenth Zephyr.—A five-car Diesel-electric streamline train to be placed in operation next spring on a daily round trip schedule between Lincoln, Neb., and Kansas City, Mo., via Omaha, Neb. It will supplant the "Pioneer Zephyr," which is to be assigned elsewhere. The new train will consist of a 2,000-hp. Diesel-electric locomotive to be built by the Electro-Motive Corp., a combination mail and baggage car having a 30 ft. railway post office, a baggage and express car, two deluxe chair cars of 52-passenger capacity, and a diner-observation car with 24 dining seats and 22 parlor car chairs. Its name will be determined by a contest. Zephyrs eleven and twelve will be ordered later for delivery in mid-year. These eight-car trains will be known as the Texas Zephyrs and will operate between Denver, Colo., and Ft. Worth, Tex. and Dallas. Each train will include a 4,000-hp. Diesel-electric locomotive, a mail-express car, a baggage-coach, two deluxe chair cars, a dining-lounge car, all of stainless steel, and three standard Pullmans.

D. C., and Birmingham, Ala., and between Washington and Atlanta, Ga. The work, which is estimated to cost approximately $275,000, will include air conditioning, reclining chairs and complete new interior fixtures and decoration throughout.

Fusion-Welded Tank Cars

THE American Car & Foundry Co. and E. I. duPont deNemours & Company, Inc., have been authorized by the Interstate Commerce Commission to construct 36 fusion-welded tank cars for experimental service in the transportation of various corrosive materials.

The General American Transportation Corporation and the American Car & Foundry Co. have been authorized by the Commission to construct 75 fusion-welded tank cars for experimental service in the transportation of caustic soda solution and petroleum products.

Diesel-Electric Passenger Locomotive Built by Alco

THE first Diesel-electric passenger locomotive to be built by the American Locomotive Company has been delivered to the Chicago, Rock Island & Pacific, where it is being used on the Rockets. This locomotive is equipped with two 1,000-hp. MacIntosh & Seymour six-cylinder, vertical, four-cycle engines.

Supply Trade Notes

C. H. MCCOLLAM, metallurgist of the steel and tube division of the Timken Roller Bearing Company, has been appointed assistant director of steel sales, with headquarters at Canton, Ohio.

◆

IRON & STEEL PRODUCTS, INC., Chicago, has established a merchant iron and steel department under the direction of J. C. Beggs, formerly of Joseph T. Ryerson & Sons, Inc.

◆

R. A. CANNON, vice-president in charge of casting sales of the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., has been appointed vice-president in charge of sales. Mr. Cannon, who is now responsible for the entire sales activities of the company, entered the service of the Birdsboro Steel Foundry & Machine Company in 1921 and became vice-president in charge of casting sales in 1929.

◆

DR. A. LLOYD TAYLOR, formerly director of the Department of Chemistry, Pease Laboratories, New York, has joined the technical staff of the Oakite Products, Inc., New York. Mr. Taylor will concentrate primarily on chemical research and development of cleaning materials for production and related cleaning operations of major industries.

◆

HOWARD R. HAFFERKAMP has been appointed supervisor of purchases on the staff of the Bendix-Westinghouse Automotive Air Brake Company, Pittsburgh, Pa. Mr. Hafferkamp will have his headquarters in the company's manufacturing division at Wilmerding, Pa.

◆

W. B. MOORE, who has been associated for 20 years with The Timken Roller Bearing Company, Canton, Ohio, in various sales activities, has been appointed director of sales of the Steel and Tube division. Mr. Moore joined The Timken Company organization as an engineer early in 1919, following his graduation from the University of Michigan. After serving in the Canton office, he was placed in charge of the company's Pacific Coast district and since 1933 has been manager of industrial sales. S. C. Partridge, assistant manager of industrial sales, succeeds Mr. Moore as manager of industrial sales.

SIDNEY D. WILLIAMS, director of sales for the Timken Steel & Tube Division of the Timken Roller Bearing Company, Canton, Ohio, has been appointed vice-president in charge of sales for the new steel division at Warren, Ohio, of the Copperweld Steel Company, Glassport, Pa. Mr. Williams was graduated from Lehigh University in 1913 with the degree of metallurgical engineer. He worked in the various departments of the Carnegie Steel Company, Homestead, Pa., until 1918, during which year he served in the United States Naval Flying Corps. He then served, successively, as superintendent of the openhearth department of the Central Iron & Steel Co., Harrisburg, Pa., and as superintendent of the openhearth department and chief metallurgist of the Pittsburgh Crucible Steel Company, Midland, Pa. From 1926 to 1940 he was, in turn, metallurgical sales engineer, assistant director of sales, manager of tube sales, and director of sales for the Timken Steel and Tube division of the Timken Roller Bearing Company, Canton, Ohio.



Photo by Parry

S. D. Williams

◆

R. C. NORBERG, vice-president and general manager of the Electric Storage Battery Company, Philadelphia, Pa., was elected president and general manager at a recent meeting of the board of directors. John R. Williams, who has been associated with the company for the past 45 years, has retired as president.

HOWARD A. FLOGAUS, assistant to vice-president of the J. G. Brill Company, Philadelphia, Pa., has been appointed chief engineer, with headquarters at Philadelphia.

◆

J. HOMER PLATTEN has been elected a vice president of the American Car and Foundry Company, New York. Mr. Platten will continue as comptroller of the company but will relinquish the office of executive assistant to the president.

◆

R. L. SALTER has been appointed engineer of tests in charge of specifications and inspections of the Association of Manufacturers of Chilled Car Wheels. The inspection department of the association is represented by resident inspectors stationed at member companies' foundries, and the finished product is subject to the association's inspection and test before it can be released for shipment.

◆

W. W. WILLIAMS, general manager of The Babcock & Wilcox Tube Co., Beaver Falls, Pa., will relinquish his position on March 1, to go into his own business on the Pacific Coast. Mr. Williams became associated with The Babcock & Wilcox organization in 1929, as sales counsellor and in turn became general sales manager and general manager of the Babcock & Wilcox Tube Co.

◆

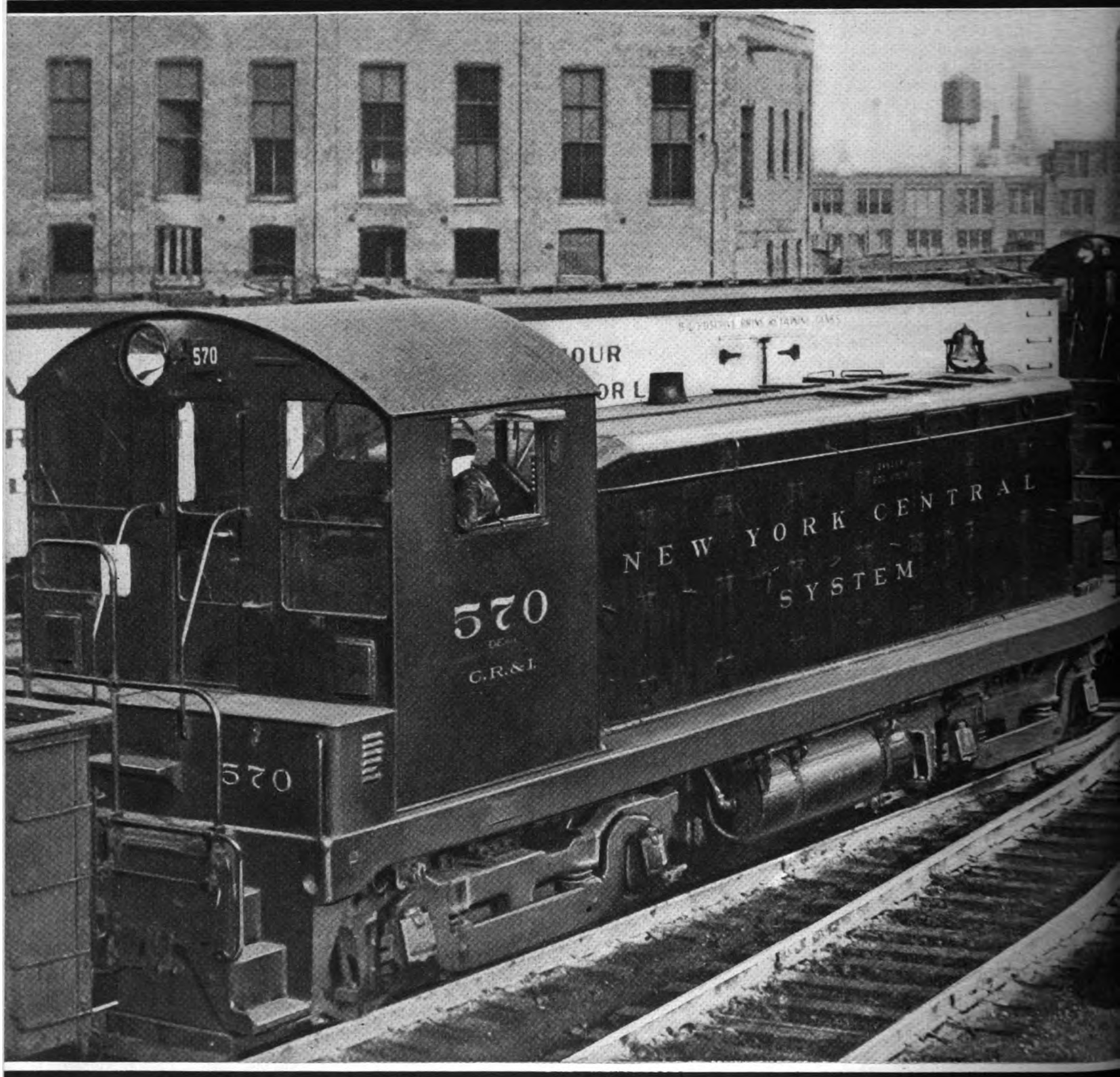
THE NATIONAL BRAKE COMPANY, INC., will move its executive office from Buffalo, N. Y., to 50 Church street, New York, effective March 1. William M. Wampler has been elected president of the company with C. T. Stansfield, vice-president; E. C. Mersereau, vice-president in charge of sales and S. T. Pearson, secretary and treasurer.

◆

JOHN W. LOHNES, assistant to general manager of sales of the Vanadium Corporation of America, has been appointed assistant general manager of sales, with headquarters at New York. Donald C. Hostettler, eastern sales representative, has been transferred to Detroit, Mich., to take charge of the Detroit district sales office as sales representative to succeed J. Berens Waters, who is assuming the duties of general purchasing agent. John B. Girdler has been appointed eastern sales representative at New York to succeed Mr. Hostettler.

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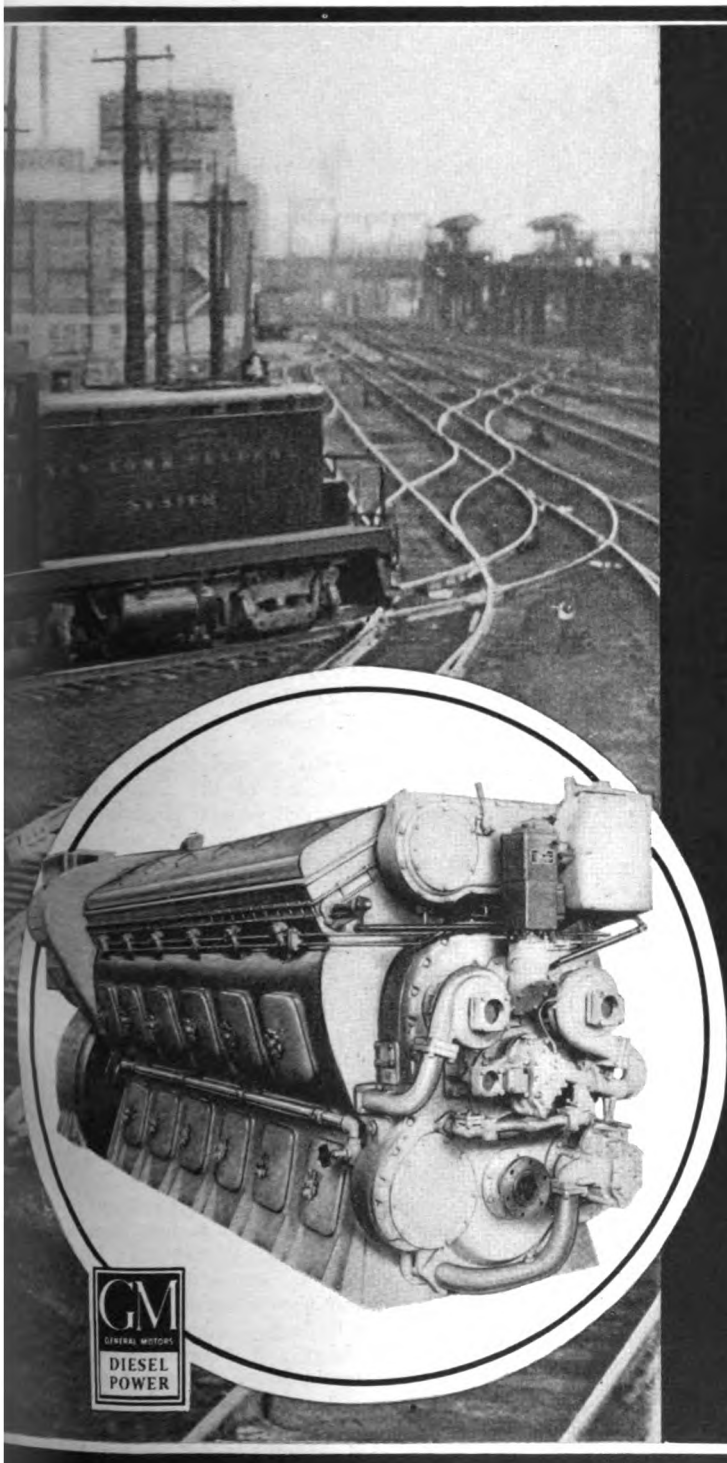


ELECTRO-MOTIVE

SUBSIDIARY OF GENERAL MOTORS

MANY OPERATING ADVANTAGES

EMC DIESEL SWITCHING ...



"A dollar saved is a dollar earned", and with EMC Diesel's low operating cost many such extra dollars can be added to net earnings.

EMC Diesel operation reduces fuel expenses by 75 per cent, maintenance costs 50 per cent, enginehouse expenses 66 per cent and eliminates water costs entirely. Added to these big economies are the following additional operating advantages which result in actual cash savings.

HIGH AVAILABILITY—SUPERIOR VISIBILITY
GREATER SAFETY—HIGH STARTING TRACTIVE EFFORT
QUICK ACCELERATION—HIGH YEAR-ROUND EFFICIENCY
FASTER AND SMOOTHER SWITCHING
CLEANER, QUIETER, SMOKELESS OPERATION

These Diesel economies are the reasons why more and more railroads are taking advantage of the fact that:

It pays big profits to switch with EMC Diesels.

CORPORATION

LA GRANGE, ILLINOIS, U. S. A.

NEREUS HUBERT ROY has recently been appointed head of the Research Department of the Waugh Equipment Company, New York. Mr. Roy was born in Bonham, Tex., on July 4, 1895. He is an authority on instruments for, methods of, and practical interpretation of investigations in connection with mechanical equipment, such as passenger and freight cars, locomotives, draft gears, rails, wheels, axles and trucks. He attended the University of Texas from 1913 to 1917, and was commissioned and served in the U. S. Army Engineers, 1917-19. To pursue more intensive study of specific engineering problems he returned to college, receiving the degree of B. S. in C. E. from the University of Texas in 1920, and the degree of B. S. in C. E. (reciprocal) from the University of Mexico in 1923. He carried on subsequent post graduate work at the University of Texas and the University of Illinois, obtaining from the latter the degree of M. S. in Theoretical and Applied Mechanics in 1929 and the Professional Degree of C. E. in 1930. During this period (1920-24) Mr. Roy had been engaged as field engineer and acting chief engineer of the International Petroleum Company, Tampico, Mex., and (1925-28) as chief engineer and general field superintendent of the Milham Corporation of Texas (Seaboard Oil Corporation). He joined the faculty of the University of Illinois, Engineering Experiment Station, in 1928 and was appointed assistant research professor in 1931, in which position he remained until the Fall of 1937. While at the University of Illinois he carried on research work on railroad engineering



N. H. Roy

problems, including the study of fissures in rails, stresses in car axles, stresses in passenger and freight cars under impact, and locomotive balance. He was engaged as research consultant by the Association of American Railroads, the Pullman Standard Car & Manufacturing Company, and several railroads. On January 1, 1938, he entered the engineering department of the Waugh Equipment Company and was appointed director of research on November 1, 1939. Mr. Roy is a member of the Western Railway Club, the New York Railroad Club, the American Association for the Advancement of Science, and Sigma Xi, National Honorary Research Society.

Obituary

AMBROSE N. DIEHL, who was president of the Columbia Steel Company from 1932 to September, 1939, died on January 3, at La Jolla, Cal., from bronchial pneumonia.

◆

CHARLES K. KNICKERBOCKER, first vice-president of the Griffin Wheel Company, Chicago, died on January 7 of pneumonia. He had been ailing for several years. Mr. Knickerbocker was born in Chicago on September 28, 1874, and entered the employ of the Griffin Wheel Company on November 1, 1894, as a shipping clerk. He was promoted to sales agent in 1895, to general sales agent in 1909, and to first vice-president in 1914. He had also been a director since 1914.

Personal Mention

General

T. R. FREDERIKS, assistant dynamometer engineer of the New York Central, has been appointed dynamometer engineer, with headquarters in New York, succeeding J. J. Anderson.

J. J. ANDERSON, dynamometer engineer of the New York Central, has been appointed assistant to assistant chief engineer motive power and rolling stock, with headquarters in New York, succeeding W. C. Wardwell.

W. C. WARDWELL, assistant to assistant chief engineer of motive power and rolling stock of the New York Central, with headquarters at New York, has been appointed assistant engineer of tests with the same headquarters, succeeding W. F. Collins.

H. T. COVER, master mechanic of the Columbus, Cincinnati and Toledo divisions of the Pennsylvania, at Columbus, Ohio, has been appointed superintendent of the Wilkes-Barre division, with headquarters at Sunbury, Pa., succeeding R. W. Sheffer. Mr. Cover was born in Altoona, Pa., on August 25, 1897, and entered the service of the Pennsylvania as a laborer on the Middle division at Altoona in August, 1915. After two weeks' work as a laborer, he was transferred to the Juniata shops in Altoona as a boilermaker helper. On June 12, 1917, he became a draftsman in the office of the general superintendent of motive power, and on January 16, 1920, was appointed a special apprentice in the Altoona machine shop. On October 18, 1922, he became a motive-power inspector, assigned to the office of the chief of motive power in Philadelphia. On May 1, 1923, Mr. Cover became assistant shop foreman on the New York division, and on July 16, 1924, advanced to the position of foreman on the same division. On May 1, 1927, he was



H. T. Cover

appointed shop foreman on the Philadelphia Terminal division, and on June 16, 1929, returned to the East Altoona enginehouse. On January 1, 1931, he was promoted to assistant master mechanic of the Maryland division at Wilmington shops, and on November 1, 1934, became master mechanic on the Buffalo division. On April 16, 1937, he was assigned to the Maryland division, and on July 1, 1939, to the Columbus, Cincinnati and Toledo divisions, with headquarters at Columbus.

DANIEL K. CHASE, superintendent of the Pittsburgh division of the Pennsylvania, has been appointed general superintendent of the eastern Ohio division, with headquarters as previously at Pittsburgh, Pa. Mr. Chase was born on June 1, 1896, at Rehoboth, Del. He attended the public schools of Rehoboth Beach and Lewes, Del., and was graduated from Pennsylvania State College (B. S. M. E., 1922). He began his railroad career on December 16, 1913, as a messenger in the transportation department of the Pennsylvania at Philadelphia, Pa. In July, 1914, he was transferred to the Altoona Works as a machinist apprentice, subsequently being appointed special apprentice, completing his apprenticeship on April 16, 1922. During this time Mr. Chase attended college, continuing his employment during vacations. After service in the World War he resumed his employment with the Pennsylvania and continued his course at Pennsylvania State College. Following service in several division and regional offices as motive-power inspector, he was appointed assistant master mechanic at Jersey City, N. J., on November 1, 1923, later serving in a similar capacity at Wilmington, Del., and Altoona, Pa. On March 1, 1927, Mr. Chase was appointed master mechanic, serving successively at Olean, N. Y.; Can-

ton, Ohio; Jersey City, N. J.; Chicago and Pittsburgh. On November 1, 1934, he was appointed superintendent, Toledo division, Toledo, Ohio; on November 1, 1935, superintendent, Eastern division, with headquarters at Pittsburgh, Pa., and on September 16, 1939, superintendent of the Pittsburgh division.

Master Mechanics and Road Foremen

H. D. ALLEN, road foreman of engines of the Ft. Wayne division of the Pennsylvania, has been appointed road foreman of engines of the Cleveland division.

J. E. MCLEOD, assistant master mechanic of the Chesapeake & Ohio at Peru, Ind., has been appointed master mechanic of the Chicago division, with headquarters at Peru.

W. R. DAVIS, master mechanic of the Chicago Terminal division of the Pennsylvania, has been transferred to Harrisburg, Pa., replacing W. B. Porter, who has been transferred.

F. R. KIRKPATRICK, assistant road foreman of engines of the Pittsburgh division of the Pennsylvania, has been appointed road foreman of engines of the Renova division.

P. T. BRIERS, general foreman of the Chesapeake & Ohio, at Hinton, W. Va., has been appointed master mechanic of the Cincinnati division, with headquarters at Covington, Ky.

J. W. LEONARD, assistant engineer of motive power of the Pennsylvania at the Altoona Works (Altoona, Pa.), has been appointed master mechanic at Chicago, succeeding W. R. Davis.

J. D. COUSINS, road foreman of engines of the Cleveland division of the Pennsylvania, has been appointed road foreman of engines of the Indianapolis division, with headquarters at Indianapolis, Ind.

J. A. WARREN, road foreman of engines of the Indianapolis division of the Pennsylvania, has been appointed road foreman of engines of the Ft. Wayne division, with headquarters at Ft. Wayne, Ind.

FRANCIS H. WINGET, who has been appointed master mechanic of the New York Central at Bellefontaine, Ohio, as announced in the January issue of the *Railway Mechanical Engineer,* was born at Pennville, Ind., on October 31, 1901. He attended grade and high schools at Pennville and was graduated in mechanical engineering from Purdue University in June, 1923. Mr. Winget entered railroad service in the employ of the Cleveland, Cincinnati, Chicago, & St. Louis on June 18, 1923, as a special apprentice at the Shelby street enginehouse, Indianapolis, Ind., subsequently serving in the shops, enginehouse and test departments at Mt. Carmel, Ill., and Beech Grove, Ind. From December, 1926, to October, 1932, he was an inspector on special assignments for the master mechanic at Bellefontaine. In October, 1932, Mr. Winget was transferred to Indianapolis as a special inspector, working directly for the superintendent of equipment. From May, 1935, until October, 1937, he was lubrication inspector, working out of Indianapolis. In October, 1937, he became assistant enginehouse foreman at Shelby street enginehouse and on April 1, 1938, was appointed assistant master mechanic of the Ohio division, with headquarters at Bellefontaine. He became master mechanic on October 1, 1939.

W. B. PORTER, master mechanic of the Philadelphia division of the Pennsylvania at Harrisburg, Pa., has been transferred to the Columbus, Cincinnati and Toledo divisions, with headquarters at Columbus, Ohio, succeeding H. T. Cover.

J. E. GARRETSON, assistant master mechanic of the Chesapeake & Ohio at Russell, Ky., has been appointed master mechanic of the Russell and Ashland divisions, with headquarters at Russell, succeeding R. G. McKee, deceased.

F. J. TOPPING, assistant master mechanic of the Chesapeake & Ohio at Stevens, Ky., has been appointed master mechanic of the Hinton division, with headquarters at Hinton, W. Va., succeeding W. V. Hinerman, whose promotion to assistant to the superintendent of motive power, was announced in the January issue.

J. ALLEN CLARK, who has been appointed master mechanic of the Northern Pacific as announced in the January issue of the *Railway Mechanical Engineer,* began his career with the Northern Pacific in 1902 on the Tacoma division. He was road foreman on the Tacoma division during 1930 and most of 1931. He returned to the cab of a locomotive during the summer of 1931, and in March, 1935, was transferred to the position of road foreman on the Rocky Mountain division, with headquarters at Livingston, Mont. He was transferred to Missoula, Mont., in March, 1938, and on November 1, 1939, became master mechanic of the Idaho division, with headquarters at Parkwater, Wash.

Car Department

WALTER E. DUNHAM, superintendent of the car department of the Chicago & North Western and the Chicago, St. Paul, Minneapolis & Omaha at Chicago, has retired.

Shop and Enginehouse

E. L. LAM, gang leader in the electrical department of the Norfolk & Western at Roanoke, Va., has been promoted to the position of assistant foreman in the erecting shop.

Obituary

CHARLES F. GILES, who retired in August, 1928, as superintendent of machinery of the Louisville & Nashville, with headquarters at Louisville, Ky., died at his home in Louisville on January 13. He had been virtually an invalid for a number of years. Mr. Giles was born at Rowlesburg, W. Va., on November 2, 1856, and entered railway service in 1873 as a machinist apprentice on the Baltimore & Ohio at Wheeling, W. Va. From 1877 to 1882, he was a machinist on this road, the Texas & Pacific, the Pennsylvania and the L. & N. and from the latter date until 1887, he was an enginehouse foreman and machine shop foreman on the latter road. In 1887, he was promoted to master mechanic at Birmingham, Ala., and on October 1, 1902, he was transferred to Louisville. On February 1, 1904, he became assistant superintendent of machinery and on June 30, 1911, he was promoted to superintendent of machinery.

ROBERT CHARLES GOREY, SR., who retired as assistant master mechanic of the Louisville & Nashville at Montgomery, Ky., on May 1, 1916, died on November 28, at the age of 82.

MAX H. WICKHORST, former engineer of tests of the Chicago, Burlington & Quincy, with headquarters at Aurora, Ill., and from February, 1910, to June, 1922, engineer of tests for the Rail committee of the American Railway Engineering Association, with headquarters at Chicago, died at Oak Park, Ill., on January 2.

CHARLES J. SCUDDER, consulting engineer of motive power of the Delaware, Lackawanna & Western, died at his home in Scranton, Pa., on Tuesday, January 30. Mr. Scudder was born at Saginaw, Mich., on September 21, 1873, and entered railway service in 1888 as a machinist apprentice on the Flint & Pere Marquette (Pere Marquette). In 1898, he became a machinist on the Detroit, Grand Rapids & Western (Pere Marquette) at Ionia, Mich., and in 1906, became master mechanic on the



Charles J. Scudder

Cincinnati, Hamilton & Dayton (Baltimore & Ohio) at Cincinnati, Ohio. Mr. Scudder was appointed general foreman, Pere Marquette, at Chicago, in 1908; superintendent shops at Saginaw, Mich., in 1909; and master mechanic in 1910. In 1911 he became a locomotive inspector of the Interstate Commerce Commission and in 1917 was appointed supervisor of equipment, United States Railroad Administration. Mr. Scudder was appointed superintendent of shops for the Delaware, Lackawanna & Western at Scranton, Pa., in 1919 and became superintendent motive power and equipment at Scranton in 1923. Last fall he retired as chief of motive power, to which position he was appointed in 1936.



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See page 87

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March, 1940

Volume 114 *No. 3*

Car:

Aluminum Alloys Feature Construction of M. P. Eagle Trains 87
The Relation Between Draft Gears and Riding Comfort 94

Locomotive:

A Study of the Locomotive Boiler 100

General:

Bureau of Safety Reports Pioneer Zephyr Wreck 107

Editorials:

Give the Foreman a Chance 109
Why Perpetuate Sloping Grates? 109
Fortunate Aspects of the Zephyr Wreck 110
Car Foremen Know Freight Car Details 110
New Books 111

Backshop and Enginehouse:

Turret Lathes in Tool Rooms 112
Guide-Locating Device for Multiple-Bearing Crossheads. 113
Gas Cutter Has Wide Flexibility 113
The Other Fellow's Job (A Walt Wyre Story) 114

Car Foremen and Inspectors:

Missouri Pacific Rebuilds Seven Chair Cars 118
Car Yard Walkways 119
Repairing Underframes of Refrigerator Cars 119
Single-Board Refrigerator Car Roof 121
Air Brake Questions and Answers 121

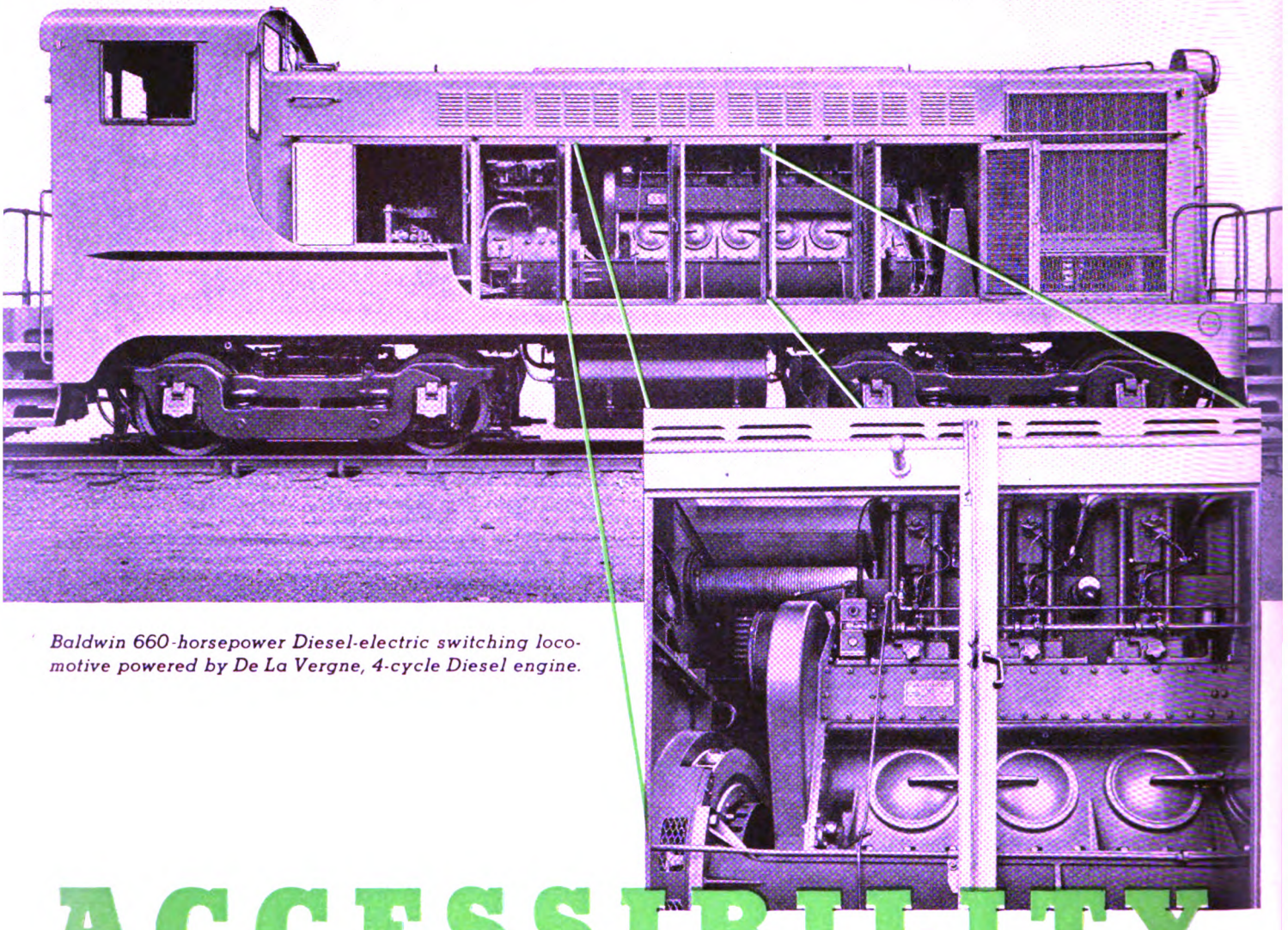
High Spots in Railway Affairs 122

Clubs and Associations 123

News 124

Index to Advertisers ..... (Adv. Sec.) 46

BALDWIN *Diesel-Electrics*



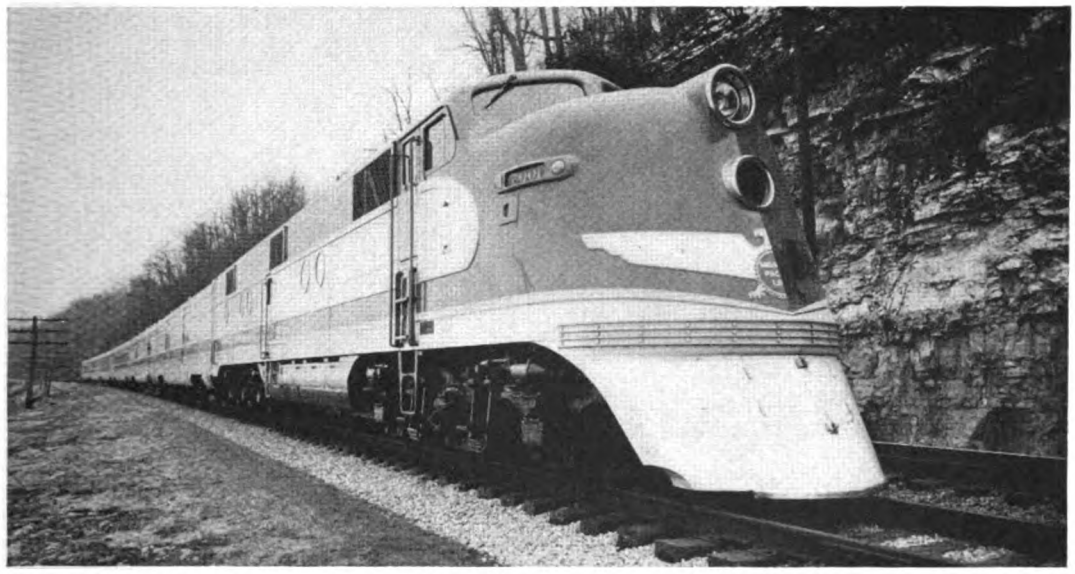
Baldwin 660-horsepower Diesel-electric switching locomotive powered by De La Vergne, 4-cycle Diesel engine.

ACCESSIBILITY

● Convenient access to all parts of the power plant of Baldwin Diesel-electric switching locomotives is provided by double doors along the sides, and hatches in the top of the hood. ● All adjustments necessary to the operation of the engine can be made without dismantling any major part. ● Such accessibility makes possible—thorough inspection—saving of valuable time—low maintenance costs.

BLW THE BALDWIN GROUP

THE BALDWIN LOCOMOTIVE WORKS



Aluminum Alloys Feature Construction of

Missouri Pacific Eagle Trains

Two six-car de luxe daylight trains, for service between St. Louis, Kansas City and Omaha, seat 230 persons each, weigh 596,980 lb. and are hauled by a 2,000-hp. Diesel locomotive

THE American Car and Foundry Company recently completed the construction, at its St. Charles, Mo., plant, of two six-car streamline trains for the Missouri Pacific. Strong aluminum alloys were used extensively in the construction of these trains, which are known as The Eagle, with the result that the total dry weight of the six cars, as shown in the table, represents a saving of approximately 40 per cent as compared with equivalent cars of conventional steel construction.

Each of the new Eagle trains consists of one mail-storage car, one baggage-mail car, one coach, one de luxe coach, one diner-lounge car and one parlor-observation car. The two head-end cars are 72 ft. 10 in. long and the other four cars are 84 ft. 6 in. long over the coupler pulling faces.

Each train is hauled by a 2,000-hp. Diesel-electric locomotive, built by the Electro-Motive Corporation, La Grange, Ill. The weight of each of these two locomotives is approximately 300,000 lb.

How the Cars Are Constructed

The six cars of each train, embodying the same basic shell construction, are designed to meet fully the requirements of the U. S. Railway Post Office specifications and the A. A. R. specifications for the construction of new passenger equipment. All materials used for the car-body framing are aluminum alloys with the exception of the bolsters, crossbearers and end sills, which are of low-alloy high-tensile steel, and the integral buffer castings and bolster center fillers, which are of unit cast steel, all assembled by riveting. Special extruded aluminum alloy sections are used for many of the framing members, the straightness and uniformity of these extrusions contributing largely to the true lines attained in the construction of the sides and roofs.

The center sills are of built-up aluminum alloy and have a minimum total cross-sectional area of 34.55 sq. in. The depth of the center sills is 16⅛ in. from top of cover plate to bottom of angle, and the construction includes a 15-in. by ⅜-in. top cover plate, 4-in. by 3-in. by ⅜-in. top angles, 7/16-in. webs, and 6-in. by 4-in. by 9/16-in. bottom angles. A further 5-in. by ¾-in. reinforcement is applied extending from the rear of the buffer casting through the bolster. The center-sill construction is connected at the rear of the draft gear to the combined buffer casting and draft-gear pocket, which has the coupler carrier cast integral and is arranged at the outer end to engage an anti-climber flange on the buffer face-plate angle.

The bolsters are low-alloy high-tensile steel of built-up welded construction, having a 20-in. by ⅜-in. top cover plate, 16-in by ½-in. bottom cover plates, and ¼-in. webs. Crossbearers are also of built-up welded construction, consisting of top and bottom cover plates with pressed diaphragms. The floor beams are of aluminum alloy, pressed pan shape. Underframe diagonal braces, applied from car corners to the center sill and bolster, are 7-in. aluminum alloy channels.

The side frames of the cars are of girder construction,

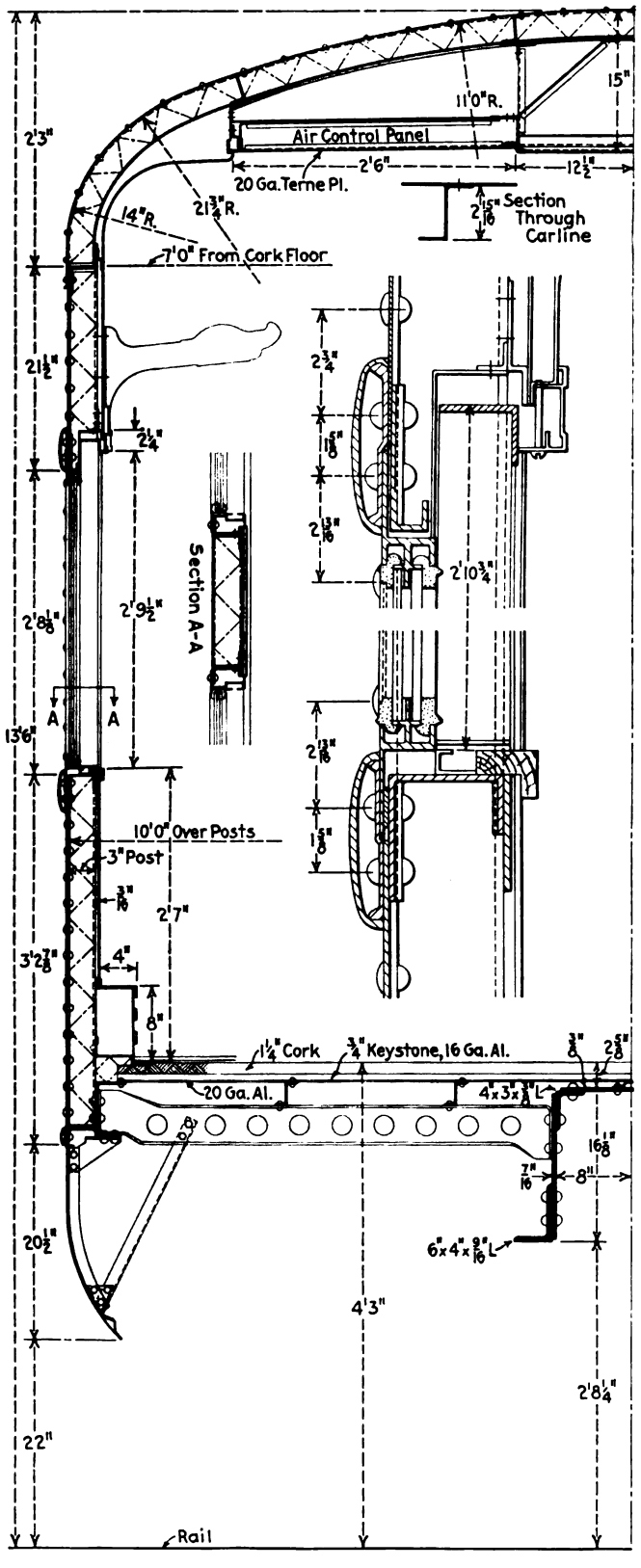
designed to carry the live and dead loads, as well as the vertical re-actions from the underframe crossmembers under buffing loads. The side sills are a special extruded aluminum section with vertical web, to which the side posts are attached, and integral flanges for supporting the floors and for attachment to underframe members and side sheets. The section is so shaped as to close completely the bottom of the side construction and absolutely exclude road dust, dirt and moisture.

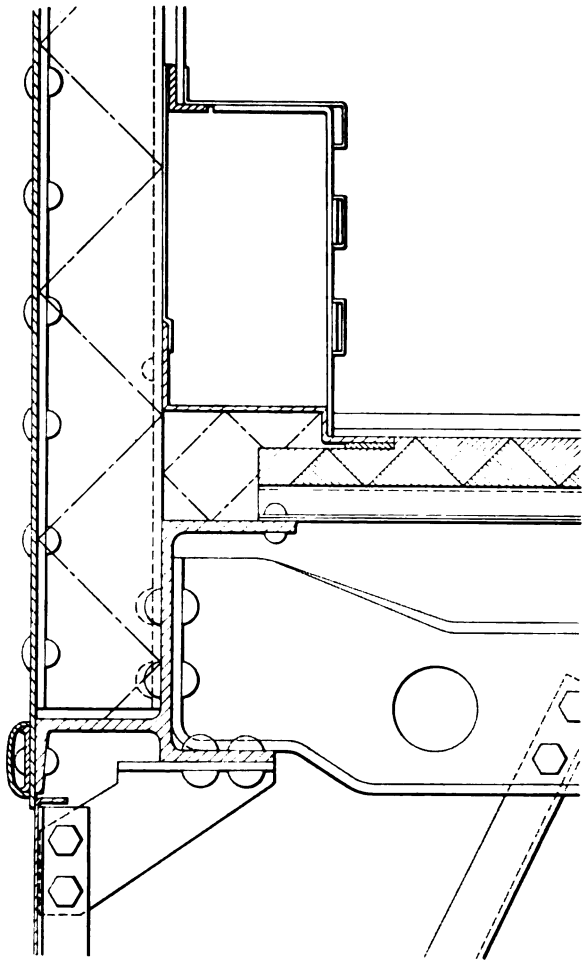
The side plates are 3-in. rolled aluminum alloy Z-shapes, and the side posts 3-in. extruded aluminum alloy Z-shapes. The belt rail construction includes 3-in. extruded aluminum channel shapes applied between posts, with a continuous inside flat bar. An outer continuous extruded shape riveted to side posts, side sheets and belt rail channel members forms the base for the attachment of the outside 4½-in. decorative anodized aluminum snap-on molding. A similar construction is used at the top of the window openings and these two anodized moldings above and below the windows extend the full length of the train, including the locomotive.

The side sheets, letterboards and pier panels are of No. 8 B. & S. gage aluminum alloy, forming the web plate of the girder construction. These side sheets and

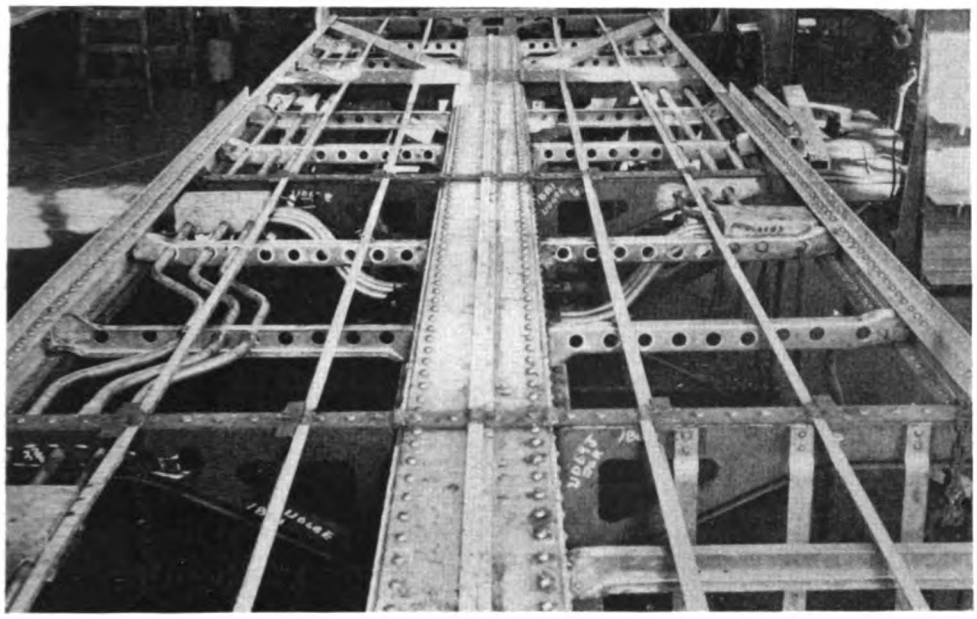
Scale Weights (Lb.) of Cars for Missouri Pacific Eagle Trains

Car	Shell	Body	Trucks	Total dry wt.	Service load	Ready to run	Seating capacity
Mail-storage	21,390	46,210	38,910	85,120	230	85,350	..
Baggage-mail ...	21,210	49,490	38,450	87,940	310	88,250	..
Coach	21,880	67,410	36,650	104,060	2,100	106,160	76
De luxe coach...	22,020	67,170	37,390	104,560	2,100	106,660	61
Diner-bar-lounge .	22,110	75,420	38,120	113,540	10,300	123,840	46
Parlor-observation	21,460	64,150	37,610	101,760	2,100	103,860	47
Total	130,070	369,850	227,130	596,980	17,140	614,120	230





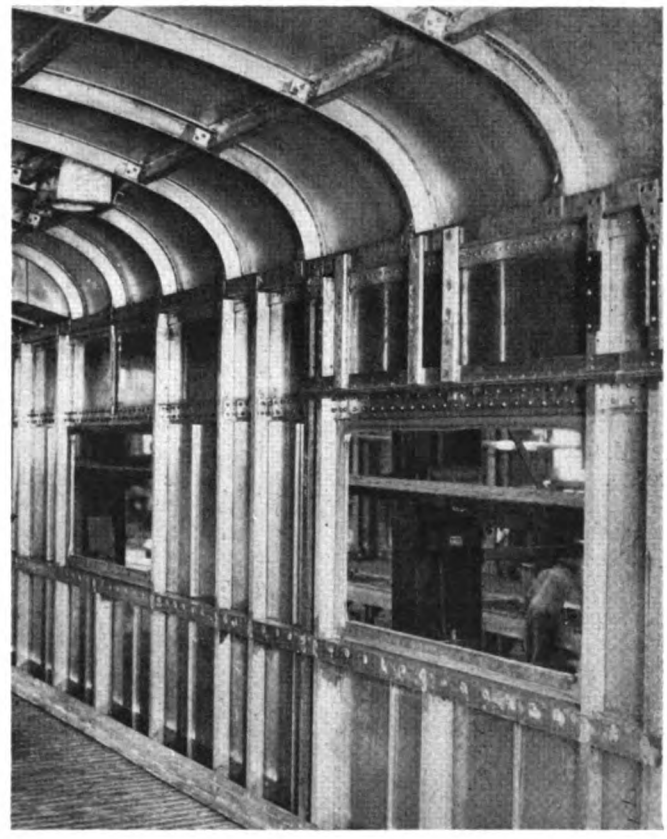
Cross-section and enlarged details of the structure of the aluminum-alloy cars of the Missouri Pacific Eagle trains



Left: The underframe is constructed with aluminum-alloy center sills and low-alloy, high-tensile steel cross members. Below: Details of the side and roof framing

letterboards are stiffened between posts by small extruded aluminum Z-shapes applied vertically by spot welding. The window frames are of extruded aluminum sections, the frame forming a structural part of the side girder, being riveted to side posts and to the belt rail and letterboard stiffener construction.

The horizontal lines of rivets in the side-frame construction are concealed by the aluminum snap-on moldings. The exposed vertical lines of side frame rivets are of aluminum, driven cold, and have a low oval head



Principal Dimensions of Eagle Cars

	Mail Storage	Comb. Mail and Baggage	Coach	De Luxe Coach	Diner-Bar-Lounge	Parlor-Obs.
Length, coupled, ft.-in.	72-10	72-10	84- 6	84- 6	84-6	84-6
Length over end sills, ft.-in.	70- 5¼	70- 5¼	78- 9⅝	78- 9⅝	82-1¼	...
Truck centers, ft.-in.	47-10	47-10	59- 6	59- 6	59-6	59-6
Inside width, ft.-in.	9- 6	9- 6	9- 6	9- 6	9-6	9-6
Mail room, length, ft.-in.	....	30- 3⅜	....	....	...	...
Passenger space, ft.-in.	....	....	66-11	49-11½	...	...
Dining room, length, ft.-in.	....	....	....	....	20-0	...
Lounge room, length, ft.-in.	....	....	....	....	13-5	...
Bar, length, ft.-in.	....	....	....	....	15-2⅞	...
Chair space, length, ft.-in.	....	....	....	....	...	46-0½
Observation room, length, ft.-in.	....	....	....	....	...	12-7⅜
Men's lounge, length, ft.-in.	....	....	5- 8¼	8- 0½	...	5-4½
Women's lounge, length, ft.-in.	....	....	5- 8¼	8- 2½	...	5-4½

of special design to minimize abrasion and wind resistance. The skirts, made of aluminum-alloy sheets spot-welded to stiffening supports, are applied below the side sills on all cars, being cut out at the trucks and provided with hinged or removable doors where necessary for access to underframe equipment. The battery box is built into the underframe construction, and a portion of the skirt, counterbalanced by a spring-controlled mechanism, forms the battery-box door.

The principal members of the end-frame construction are the two diaphragm posts, made of 8-in. extruded aluminum-alloy channel sections. These posts extend into pockets in the buffer castings, and are supported at the top by the anti-telescoping construction, which consists of a 10-in. aluminum-alloy channel at the stub ends and a truss girder construction at vestibule ends, which includes the vestibule ceiling with suitable aluminum angle stiffeners. The diaphragm posts have a web thickness in the lower portion to meet fully the A. A. R. specification for shear resistance, and for weight saving the upper portion of these posts has the web thickness reduced by machining. The intermediate end posts are 4-in. by ¼-in. aluminum-alloy rolled Z-shapes and the corner posts are a special extruded aluminum section with integral flanges for the attachment of inside finish.



Mirrored panels, aluminum Venetian blinds and fluorescent lighting in side troughs and ceiling wells accentuate the attractiveness of the dining room. Below: The observation lounge at the rear end of the chair car is equipped with built-in radio, two fixed sofas and lounge chairs

Roof and Floor Construction

The roof frame is made of 3-in. aluminum alloy extruded Z-section carlines with four lines of extruded Z-section purlines. The roof sheets are .0781 in. aluminum alloy. The roof rivets are steel, driven hot, with exposed heads of a special low oval design.

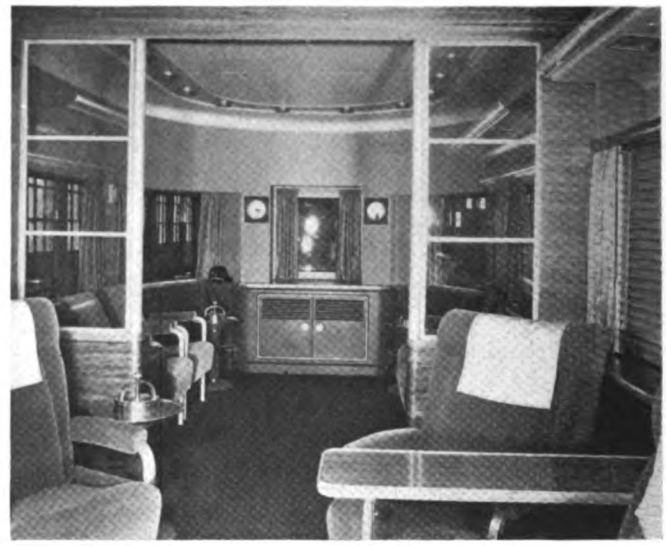
The longitudinal floor stringers in the underframe construction are aluminum alloy Z-shapes supported by the underframe crossmembers. Keystone floor sheets ¾ in. high, of No. 16 B. & S. gage aluminum alloy, have the lower grooves filled with lightweight insulation, after which the false floor sheet is spot-welded to the under side of these keystone floor sheets. The keystone floor sheets with the false floor sheets attached, are then applied on top of the floor stringers, after which the upper grooves are filled with lightweight composition floor material. On top of this keystone floor is applied 1¼ in. of compressed cork, cemented in place. The upper floor in the kitchen and back of the bar are cast aluminum with an abrasive surface, and this same material is used for thresholds, buffer foot-plates and vestibule step treads.

In the two head-end cars, the floor construction includes the same false floor as in the other cars, wood floor stringers with insulation between, then double wood floors with paper between, and a third course of wood flooring applied crosswise at the baggage side doors.

The compressed cork and the materials applied in the upper and lower grooves of the keystone, constitute the floor insulation. Fiberglas insulation, secured in place by wires, is used in the sides, ends and roofs, including 3 in. thickness in the sides and 2 in. in the ends of cars, 3 in. in the roofs of passenger-carrying cars and 2 in. in the roofs of head-end cars. Anti-squeak composition cork tape is used to break the direct metallic connection between the inside finish and the car framing.

Vestibules

Both ends of all cars are equipped with sheet rubber closures, following the outside contour of the car and forming continuous lines between coupled cars and between the head-end car and the locomotive. The side section of the closure face-plate construction is hinged to the center section, which is supported by suspension rods to the car body, and face plates are held in contact



by coil springs and by semi-elliptic upper buffer springs.

Inside vestibule diaphragms are used on all cars, and vestibule curtains and tail gates on passenger-carrying cars. Trap doors are of aluminum, operated in conjunction with the folding steps, which form a continuous line with side skirts when closed.

Styling of the Trains

The car equipment for the Eagle trains was styled by Raymond Loewy, industrial designer, New York. The cars are so designed that with the locomotive they appear as a unit streamline train, this effect being accentuated by the exterior color treatment. Against a background color of deep green-blue, a continuous horizontal panel runs from near the front of the locomotive to the rear end of the observation car. Accentuated by means of creamy white lines, the light gray panel is defined by two broad bands of polished aluminum. A unique window treatment, varying oblong 5-ft. wide windows with round port holes, relieves any sense of monotony.

A focal point of the exterior design appears in the emblem of the train, which is an eagle. The eagle's wide-spreading polished metal wings blend with the con-

tours of the locomotive and give emphasis to this motif as a symbol of beauty, strength and swiftness. The insignia is repeated on the rear of the observation car in full relief, sculptured in cast aluminum.

The intermediate cars between the observation car and the locomotive have straight ends to permit closing the space between the cars with rubber curtains, thus adding to the unit effect. Each car, however, is independent as far as its equipment is concerned and may be operated in any train in standard Association of American Railroads interchange traffic.

Coach Interiors

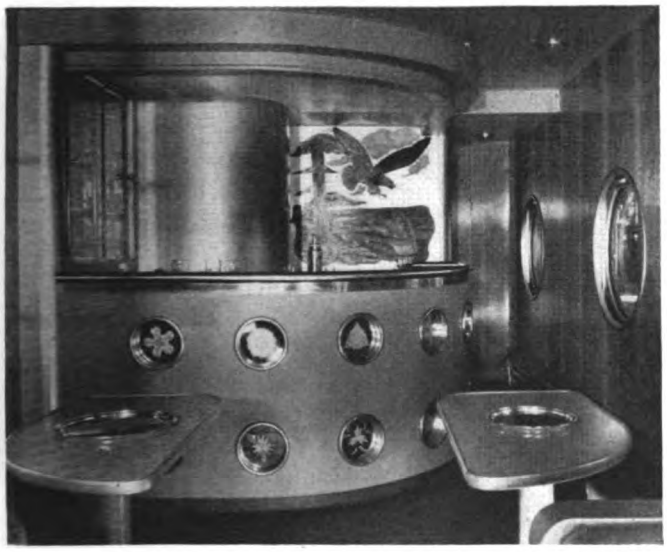
The first coach is equipped with seats for 76 passengers and behind it is a second or de luxe coach which provides seats for 61 passengers and offers the maximum in coach service. Features which lend luxury and comfort include deep pile carpeting, reclining chairs, Venetian blinds and hand-loomed curtains. The only basic difference in the two cars is that in the de luxe coach, lounge rooms are provided at either end for men and women passengers who travel longer distances.

The color scheme for the coaches has been developed in varying shades of blue, which is set off by a pale yellow ceiling. From the deep, rich blue tones of the carpet that strike the color keynote, soft, gray-blue is used for the walls above the windows and the baggage rack. The dark blue tone of the chair upholstery repeats the blue of the carpet.

The bulkheads have been given a surface treatment that contrasts deep-blue satin-finish lacquer with a silvery tone which is carried through to the passageway. The significant motif of the eagle insignia, designed in red, gray and blue plastic, appears as an embellishment on the bulkheads. The Venetian blinds are of silver color with hand-loomed texture curtains, horizontally striped with mulberry and blue against a natural background.

For general car illumination, circular wells of light in the form of specially designed fixtures are set into the ceiling. These give direct light to the aisles and by means of circular spun-aluminum reflectors outlining the fixtures a spread of indirect light is thrown against the ceiling. In addition, there are individually controlled lighting fixtures set flush into the bottom of the baggage rack that provide direct illumination for reading.

The women's lounge has been screened with blue grass-cloth portiers that appear against the silver of the passageway. Soft pastels, such as light blue and dusty pink, are combined in charming effects. There is a sofa upholstered in a wood rose tone, flooring of pale blue rubber with off-white inlay, and a vanity dressing table of glass and aluminum. The men's lounge makes use of more masculine materials, such as knotty pine and wood panelling, pigskin upholstery, and flooring of biege with black inlay.



The Diner-Bar-Lounge Car

Beginning with the coach end of the diner-bar-lounge car is a modern kitchen completely equipped for diner service. The middle of the car is the dining compartment with tables seating 24 passengers. Separated from the dining compartment by a false partition is the bar-lounge compartment, accommodating 22 passengers and designed so that it may be used as an additional dining compartment if conditions warrant. At the rear end of the car is the bar which serves not only this car, but also the parlor-observation car which follows.



The bar at the rear end of the diner-bar-lounge car. The ceiling in this section is lower than the rest of the car and is finished in blue, with walnut on the walls. Right: The 26-chair parlor section, looking toward the stateroom end of the car. Side and ceiling lights are used effectively

Partial List of Materials and Equipment on the Missouri Pacific Streamline Trains Built by the American Car and Foundry Co.

Aluminum shapes, plates, sheets, castings, and outside snap-on moldings	Aluminum Company of America, Pittsburgh, Pa.
Quick-Lock molding	Kinkead Industries, Inc., Chicago
Steel castings	American Steel Foundries, Chicago
Cor-Ten steel	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Truck frames, cast steel	General Steel Castings Corp., Eddystone, Pa.
Wheels (3)	Armco Railroad Sales Company, Middletown, Ohio
(3)	Bethlehem Steel Company, Bethlehem, Pa.
(3)	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
(3)	Standard Steel Works Company, Burnham, Pa.
Springs	American Locomotive Company, Railway Steel Spring Div., New York
Axles	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Upper buffer spring	Standard Railway Equipment Mfg. Co., Chicago
Buffer castings	General Steel Castings Corporation, Eddystone, Pa.
Draft gear	Waugh Equipment Company, New York
Couplers, yokes and journal boxes	National Malleable and Steel Castings Co., Cleveland, Ohio
Coupler-centering device	American Car and Foundry Company, New York
Bolster-locking center pin	W. H. Miner, Inc., Chicago
Side bearings	Alcoma Railway Equipments, Chicago
Shock absorbers	Monroe-Evans Railway Equipment Div., Evans Products Company, Monroe, Mich.
Journal wedges	American Car and Foundry Company, New York
Journal bearings	National Bearing Metals Corp., St. Louis, Mo.
Dust guards	Railway Equipment Div., Portable Plating Company, Chicago
Roller-bearing wheel units with SKF roller bearings	American Steel Foundries, Chicago
Sound-deadening pads	United States Rubber Company, New York
Electro-pneumatic brakes	Westinghouse Air Brake Company, Wilmerding, Pa.
Simplex clasp brakes	American Steel Foundries, Chicago
Hand brakes	W. H. Miner, Inc., Chicago
Brake shoes	American Brake Shoe & Foundry Co., New York
Inside diaphragms	Tuco Products Corporation, New York
Diaphragm rubber	United States Rubber Company, New York
Vestibule curtains	The Adams & Westlake Co., Elkhart, Ind.
Vestibule face-plate lining	Scandinavia Belting Company, Newark, N. J.
Trap doors	O. M. Edwards, Inc., Syracuse, N. Y.
Threshold plates	American Abrasive Metals Company, Irvington, N. J.
Platform rubber	United States Rubber Company, New York
Weatherstrip	Midgley & Borrowdale, Chicago
Fiberglas insulation	Gustin-Bacon Manufacturing Company, Kansas City, Mo.
Doors, inside	Haskelite Manufacturing Corporation, Chicago
Doors, outside	American Car and Foundry Company, New York
Door springs	American Spiral Spring & Mfg. Co., Pittsburgh, Pa.
End door hinges	Loeffelholz Company, Milwaukee, Wis.
End door locks	Dayton Manufacturing Company, Dayton, Ohio
Locks	Yale & Towne Mfg. Co., Stamford, Conn.
Door tracks and hangers; bagg.-mail side door hangers	Richards-Wilcox Mfg. Co., Aurora, Ill.
Door closers	Norton Lasier Company, Chicago
Mail-room fixtures	American Car and Foundry Company, New York
Masonite	Masonite Corporation, Chicago
Plymetl	Haskelite Manufacturing Corporation, Chicago
Marlite	Marsh Wall Products, Inc., Dover, Ohio
Anti-squeak tape	Armstrong Cork Company, Lancaster, Pa.
Flooring	Tuco Products Corporation, New York
Keystone floor	American Car and Foundry Company, New York
Rubber floor covering	Goodyear Tire & Rubber Co., Inc., Akron, Ohio
Cork base	Armstrong Cork Company, Lancaster, Pa.
Floor cement	Presstite Engineering Company, St. Louis, Mo.
Sash, passenger-car	Hunter Sash Company, Inc., Flushing, L. I., N. Y.
Sash, baggage-mail car	O. M. Edwards, Inc., Syracuse, N. Y.
Glass	Pittsburgh Plate Glass Company, Pittsburgh, Pa.
Pressed prism safety glass	Pressed Prism Plate Glass Company, Chicago
Window-sill capping, Micarta	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Pneu-pad	Midgley & Borrowdale, Chicago
Window curtains	The Adams & Westlake Co., Elkhart, Ind.
Venetian blinds	H. B. Dodge Company, Chicago
Tekko wall covering	Frederic Blank & Co., New York
Carved glass medallions; carved wood panels	Regal Glass Corporation, New York
Plastic emblems	Treitel-Gratz Company, New York
Display frames	Dayton Manufacturing Company, Dayton, Ohio
Formica	The Formica Insulation Company, Cincinnati, Ohio
Reclining seats	Coach & Car Equipment Co., Chicago
	S. Karpen & Bro., Inc., Chicago
Seat cushions	Firestone Tire & Rubber Co., Airtex Division, Fall River, Mass.
Parlor-car chairs	Heywood-Wakefield Company, Gardner, Mass.
Tables	General Fireproofing Company, Youngstown, Ohio
Upholstery fabrics	Blanchard Bros. & Lane, Newark, N. J.
	L. C. Chase & Co., Inc., New York
	H. D. Taylor Company, Buffalo, N. Y.
Drapery materials	Cromwell Designs, Inc., New York
	Gustin-Bacon Manufacturing Company, Kansas City, Mo.
	Morton Sundour Company, Inc., New York
	Rodoma, Inc., New York
	Rosewood Weavers, New York
	F. Schumacher & Company, New York
Carpet	Chas. P. Cochrane Company, Philadelphia, Pa.
Bars	Southern Equipment Company, St. Louis, Mo.
Bar fixtures	The Adams & Westlake Co., Elkhart, Ind.
Bar mural	Painted by Mrs. Buell Mullen, Evanston, Ill.
Clocks	A. W. Fowler Manufacturing Company, Highland, Ill.
Ash stands and serving trays	Marshall Field & Co., Chicago
Ash receivers	The Adams & Westlake Co., Elkhart, Ind.
Parcel racks	Safety Car Heating & Lighting Co., New York
Kitchen range	Stearnes Company, Chicago
Kitchen and pantry equipment	Duke Manufacturing Company, St. Louis, Mo.
Range oil burner	Williams Oil-O-Matic Heating Corp., Bloomington, Ill.
Dish washer	Surgex Manufacturing Company, Oakland, Cal.
Drinking-water cooler	General Electric, Schenectady, N. Y.
Water filters	Henry Giessel Company, Chicago
Water purifier	Tested Appliance Company, Chicago
Batteries	Edison Storage Battery Div., Thomas A. Edison, Inc., West Orange, N. J.
Charging receptacles	The Pyle-National Company, Chicago
Axle lighting equipment	Safety Car Heating & Lighting Co., New York
Lighting fixtures	The Adams & Westlake Co., Elkhart, Ind.
	Dayton Manufacturing Company, Dayton, Ohio
	Safety Car Heating & Lighting Co., New York
Fluorescent lamps	General Electric, Schenectady, N. Y.
Fluorescent starter	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Electric wire	General Cable Corporation, New York
	Kerite Insulated Wire & Cable Co., New York
Electric conduit	Appleton Electric Company, Chicago
Cable connectors	Thomas & Betts Co., Elizabeth, N. J.
Back-up and marker lights	The Pyle-National Company, Chicago
Annunciators	Edwards & Co., Inc., Norwalk, Conn.
Motor-generator sets (for radios)	Janette Manufacturing Company, Chicago
Radios	RCA Manufacturing Company, Inc., Camden, N. J.
Air-conditioning equipment	Safety Car Heating & Lighting Co., New York
Exhaust blowers	B. F. Sturtevant Company, Hyde Park, Boston, Mass.
Mail-room fans	Safety Car Heating & Lighting Co., New York
Exhaust fans	Diehl Mfg. Co., Elizabethport, N. J.
Exhaust ventilators	American Car and Foundry Company, New York
Uni-Flo grilles	Barber-Colman Company, Rockford, Ill.
Perforated aluminum ceiling and multi-vent panels	The Pyle-National Company, Chicago
Heating equipment and air-conditioning controls	Vapor Car Heating Company, Inc., Chicago
Train connectors	The Pyle-National Company, Chicago
Dry hoppers; folding washstands	The Adams & Westlake Co., Elkhart, Ind.
Flush hoppers	Duner Company, Chicago
Lavatories; copper pipe and fittings	American Radiator & Standard Sanitary Corp., New York
Copper pipe fittings	Mueller Brass Foundry Co., Port Huron, Mich.
Pipe insulation	Union Asbestos & Rubber Co., Chicago
Motor alternators	Safety Car Heating & Lighting Co., New York
Speed indicator	Electric Tachometer Corp., Philadelphia, Pa.
Car oil	The Texas Company, New York
Wool waste	National Waste Company, New York
Fire extinguishers	Pyrene Mfg. Co., Newark, N. J.
Decorative eagle rear of train	Aluminum Company of America, Pittsburgh, Pa.
Paint, exterior	E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Paint, interior	The Mitchell-Mayer Company, Inc., St. Louis, Mo.
	Murphy Varnish Company, Newark, N. J.
	Pratt & Lambert, Inc., Buffalo, N. Y.

The dining compartment is separated from the bar-lounge compartment by a swinging door, on either side of which has been set a mirror panel, etched with fruit, flower and vegetable motifs. These mirror panels are used again for decorative effect at the opposite end of the section, thus giving to the entire dining car a quality of brilliant beauty.

The ceiling, which is of silver opalescent lacquer, is curved into the bulkheads to give flowing continuity to the interior architectural and decorative effects. The soft sheen of silver is repeated in the aluminum Venetian blinds that are used for the wide windows. Above the windows is a light trough, accented with strips of translucent plastic, that runs the continuous length of the section. Fluorescent lights are set into this trough which is designed so that light is reflected downward on the tables and upward on the walls above the windows. On this wall section a new decorative fabric with a rose and silver opaline surface has been used, and the upward rays of fluorescent light highlight the beauty and reflecting quality of this luminous material. Ceiling wells of fluorescent light, shaded with large plastic sheets, are used for the general illumination of the dining section.

The general color scheme of the dining car is built around harmonious contrasts, such as gray-blue as used for the side ceiling and silver-rose for the drapery. These tones are strengthened by the deeper tone of the rose-taupe upholstery, dramatic emphasis being given by the rich claret-red of the carpet.

The bar-lounge section is divided by glass panels and achieves a club-like atmosphere with its four intimate bridge groupings in the lounge section and the inviting bar section with its friendly built-in seats. Windows in the lounge section have been grouped to make one large unit. An aluminum frame outlines the window group, with hand-loomed rough-texture curtains of blue fabric at either end. Lighting fixtures that give pleasant, glareless illumination have been set into the lowered side ceiling to throw direct rays on the bridge tables. Glass fixtures that reflect their light against spun aluminum inverted bowls provide additional illumination. Decorative wood pier panels, carved and sandblasted in oak, portray two figures of mankind, symbolic of American agriculture and industry.

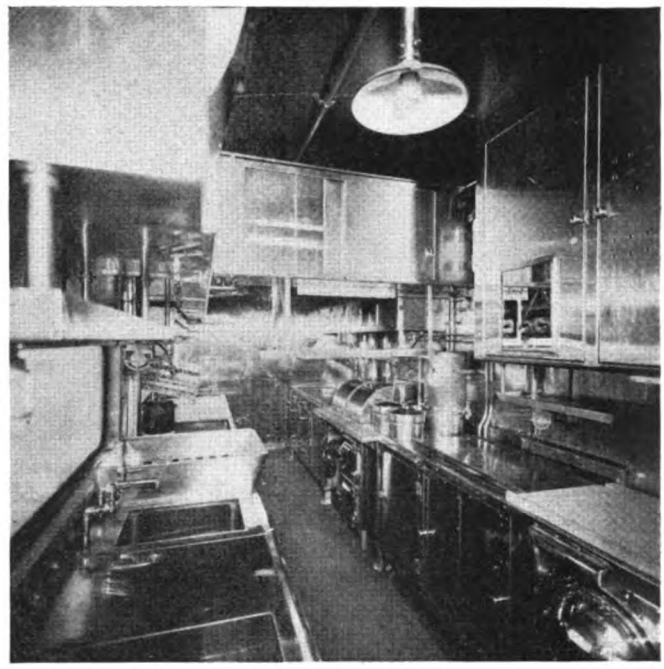
At the far end of the car a curved bar predominates. Original and attractive in design, it has a facing of bright blue. Set into the blue background are 14 illuminated circles of carved glass, depicting the flowers of the states through which the Missouri Pacific lines pass. The large color mural, painted on aluminum on the back wall of the bar, symbolizes the speed and swiftness of the new streamliner as well as its emblem, the eagle.

In the bar-lounge section, the soft gray tones of the heavy pile carpet act as a foil for the yellow leather upholstery and the blue walls and draperies. Deep yellow on the side ceiling picks up the upholstery color. Plastic table tops are of pearl gray Formica to contrast with the burgundy built-in seats adjoining the bar. For the bulkheads, silver and opalescent glass at one end contrast with mirrors at the other end.

The ceiling of the bar section is lower than the lounge ceiling to give a more intimate feeling in this section. It is painted blue, in effective combination with the old Claro walnut of the walls. There are two built-in sofas, upholstered in burgundy needlepoint. Over these have been set individual lights that carry through as a panel to the vestibule. Above the sofas are port-hole windows.

Parlor-Observation Car

The parlor-observation car has men's and women's lounges at the forward end. There is a drawing room between these lounges and the passenger chair space. The observation room occupies the rear end of the car. The parlor car seats 26 persons with chairs for six additional persons in the observation room. Swivel lounge chairs, with reclining backs, together with large windows and wide window sills serve to make this a particularly comfortable and pleasant room. The lighting consists of triple-unit center fixtures and individually-controlled units at each seat.



The kitchen equipment is stainless steel

At the observation end, with its built-in radio, there are two fixed sofas and four deep-seated lounge chairs. A clock and a speedometer, designed in aluminum and plastic, decorate the wall.

The drawing room has a built-in sofa, movable chairs, built-in cabinets, and table lamps. One wall is walnut Marlite, contrasted with apple green on the other three. Reading lights above the sofa also illuminate three Currier and Ives prints of old locomotives.

Kitchen Equipment

The kitchen interior equipment is all of stainless-steel construction. The range is designed to burn oil, and ample refrigerator capacity is provided with water-ice refrigeration. An electic dish-washer is applied in one of the sinks at the side wall of the car.

Kitchen ventilation is supplied by a ⅓-hp. double exhaust blower over the range, with fresh air intake and filter in the lower part of the kitchen side door. The water-carrying capacity on the diner-bar-lounge car is 400 gal., with 300 gal. in two stainless-steel tanks under the car and 100 gal. in an overhead tank in the kitchen.

Lighting Equipment and Air-Conditioning

The two head-end cars are each provided with Safety 4-kw. underframe axle-light equipment having flat belt drive. The passenger-carrying cars have Safety 15-kw. equipment with V-belt and gear drive. Edison storage batteries of 900-amp.-hr. capacity are used on passenger-carrying cars, and 375-amp.-hr. capacity on head end cars. Lighting fixtures are all of special design. The Mazda 32-volt light load is 2,900 watts in each coach, 2,475 watts in the diner and 3,780 watts in the parlor-observa-

(*Continued on page 108*)

The Relation Between

Draft Gears and Riding Comfort

The effect of different arrangements of draft gears, buffers, and couplers on the riding qualities of passenger cars as determined from tests made by the Waugh Equipment Company

THE data obtained from an extensive series of tests conducted by the Waugh Equipment Company, New York, with a ten-car passenger train of 70-ton coaches leased from the New York Central show the relationship of draft gears to the riding comfort of passenger cars. For several years the unusual riding comfort of trains equipped with Waughmat Twin Cushions has given practical proof that these draft gears reduce or eliminate shocks and vibrations and contribute greatly to smooth riding. The tests were made to procure reliable evidence of the actual and comparative values of Waughmat Twin Cushions, friction draft gears, buffers, and other arrangements of Waughmats.

The test runs were made almost daily on the Mohawk division of the New York Central between Albany, N. Y., and Utica, a distance of 95 miles. Thirty-nine round trips were made over this district. Only the first three cars were equipped with test gears as it is obvious that a daily change of draft gears in all ten cars would have required considerable time and presented other difficulties.

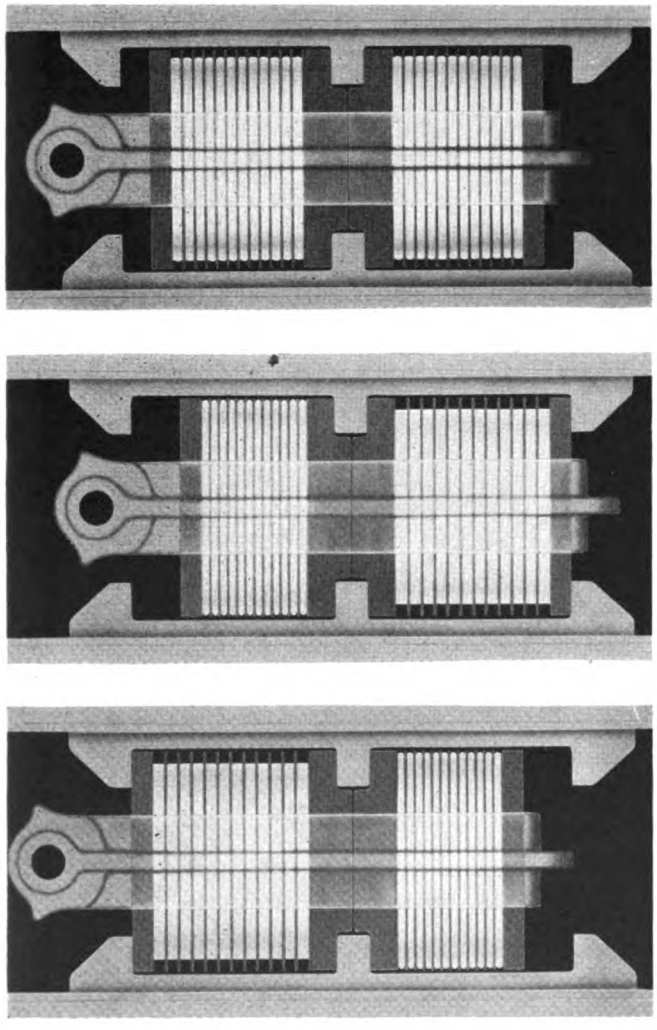


Fig. 1—The Waughmat Twin Cushion in its normal position (top), under buff with front unit compressed, rear expanded, (center), under pull with rear unit compressed, front expanded (below)

It was realized that the protection afforded by the gears in the first three cars would not be as great as might be expected if the entire train had been equipped with Twin Cushions and this fact should be kept in mind while examining the data. The remaining seven coaches were equipped with friction draft gears and remained unchanged throughout the tests. The buffers were removed from the test cars for all tests except those on the last two days and the diaphragms were pinned back so that the operation would be entirely upon the draft gears.

The equipment tested consisted of two types of well-known friction draft gears, Twin Cushions, Waughmat buffers for the last two days of tests, various arrangements of Waughmats, standard couplers, and standard couplers tightly locked by means of a rod and turnbuckles.

A friction draft gear is a mechanism capable of cushioning shocks, properly housed, which fills the space between the stops in the draft-gear pocket in its normal position. This type of gear shortens under a buffing or pulling action, and as it does so it offers frictional resistance to such action. The amount the gear shortens depends upon the load and the rate of loading. Upon reversal of the direction of motion of the car, the draft gear has to travel the distance it was previously shortened before it can again offer any resistance to buffing or pulling. The change in direction of motion is often so fast that this type of draft gear cannot respond quickly enough to prevent high shocks.

The Waughmat Twin Cushion, Fig. 1, consists of two groups of Waughmat steel-rubber springs arranged each side of the center lugs, which are attached to the car. The units are applied in such a manner that when a pulling or pushing force is delivered to the coupler, one unit is compressed, thereby absorbing the shock, while the other unit expands. When the direction of movement is changed, the expanded unit immediately absorbs the shock resulting from the change. By thus maintaining a tight connection between the coupler and the car structure and preventing open spaces at the ends, the Twin Cushion eliminates the uncontrolled movement in the connections which creates the dynamic shocks that occur so frequently in service.

Test Instruments and Procedure

As the object of these tests was to determine the effect on the cars of the various arrangements of draft gears and buffers, it was necessary to obtain permanent and continuous records of the draft-gear action. The draft-gear travel instrument, Fig. 2, was designed and built for this purpose. It was mounted directly behind the front draft-

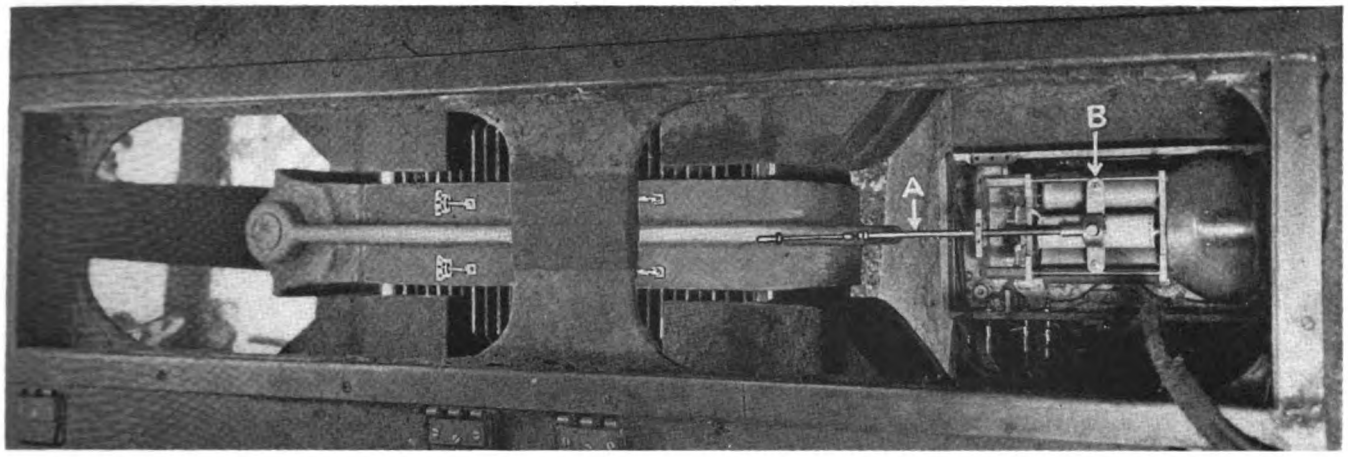


Fig. 2—The draft-gear travel instrument in position behind the draft-gear pocket—Four strain gages may be seen on the top of the yoke

gear pocket on each of the first two cars and recorded graphically all of the movements of the yoke, even to the slightest vibrations, throughout each test run.

Referring to the illustration of the draft-gear travel instrument, the marker arm (A) was welded to the rear end of the yoke, and the marker stylus (B) recorded the yoke movements directly on the moving chart, which ran at a speed of ¼ in. per second. By means of a time recorder each second was marked automatically on the chart. A code mark corresponding to the "log of events" was marked on the graph by a marker which was controlled from a master key. Thus, it was possible to reach cause and effect conclusions regarding all draft-gear actions.

Accurate data as to the magnitudes and frequencies of longitudinal, vertical, and lateral shocks, as well as the oscillating or surging of the cars, were obtained from records produced by shock recorders. A three-way shock recorder, Fig. 3, was mounted on the floor in the center of each of the first two cars. To assure a constant chart speed the draft-gear travel instrument and the three-way shock recorders were connected to a master control board which was continuously under the observation of a member of the test crew.

The details of the three-way shock recorder are shown in the illustration. Markers (A) recorded longitudinal shocks and oscillations, (B) and (C) lateral shocks and side sway, both right and left, and (D) vertical shocks and vibrations. The chart moved at a speed of ¼ in. per second, each second being automatically recorded by means of the time marker (F). A code mark corresponding to the "log of events" was marked on the graph by means of marker (E) from the same master key and at the same time that the draft-gear travel instrument was marked, thus synchronizing these instruments.

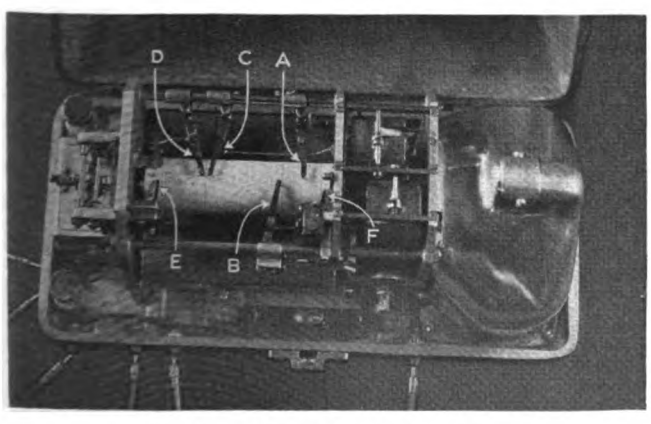


Fig. 3—The three-way shock recorder

A two-way shock recorder was located on the floor at each end of the first two cars. It recorded longitudinal and vertical shocks. These instruments were clock driven at a speed of 12 in. per hour so that it is easy to locate on the chart the place at which each shock occurred.

It was considered desirable to determine the magnitudes of the stresses in the draft-gear yokes and coupler shanks during the test runs from two points of view, (1) the effects of the stresses themselves, and (2) the values of the stresses as a measure or indication of the shocks to which the passengers and cars were subjected.

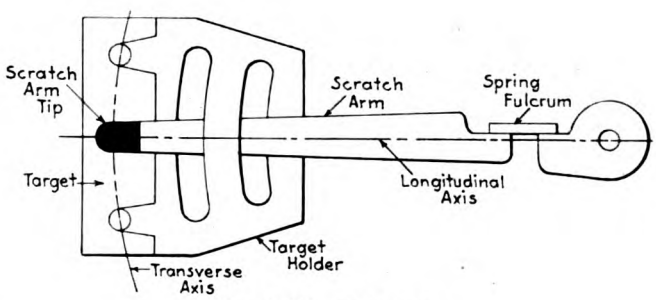
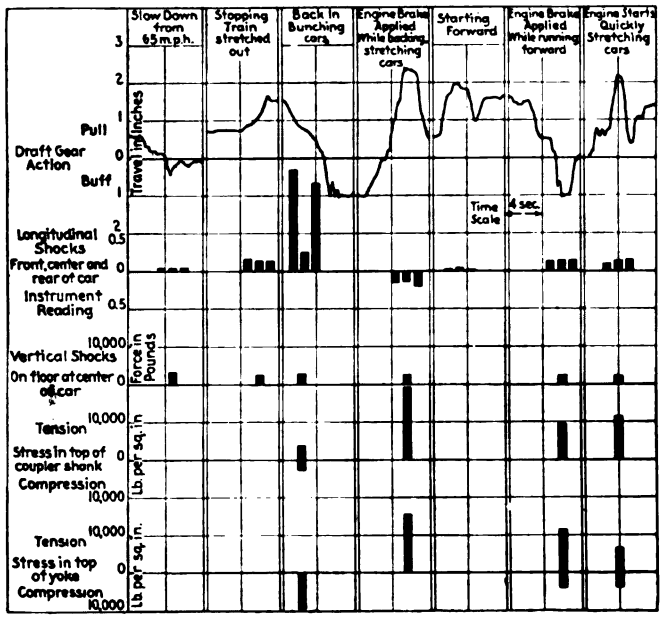


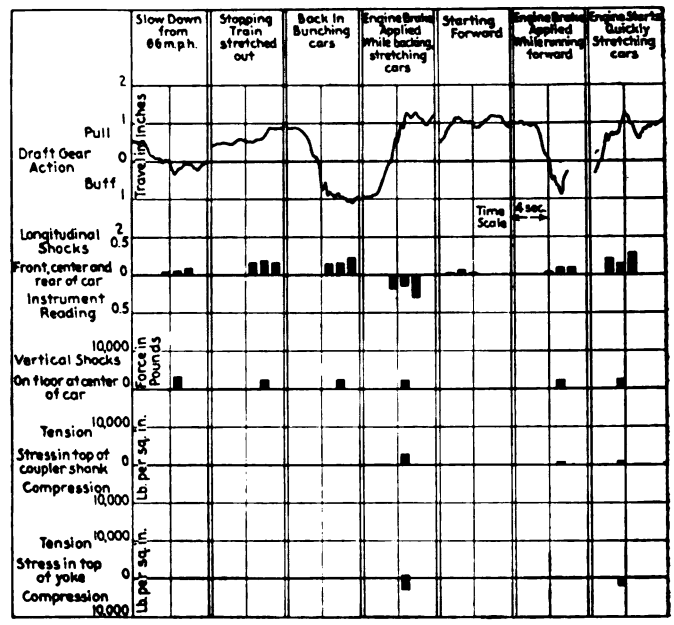
Fig. 4—The strain gage

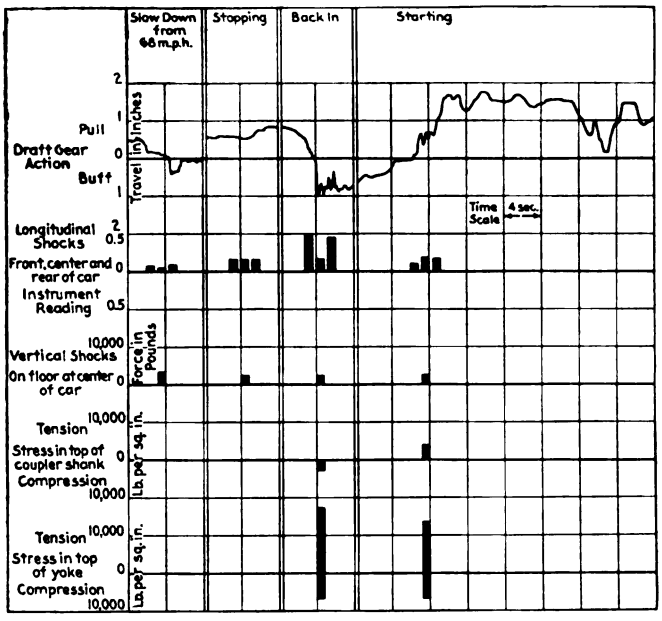
For this purpose several recording scratch strain gages were employed to determine the strains occurring in the coupler shank and the draft-gear yokes. The strain gage, Fig. 4, consists of two simple parts—a scratch arm carrying a number of diamond dust particles embedded in a matrix of cured rubber under its tip which scratch when moved, and a holder for a polished chrome plated recording surface or target on which the records of the strains are scratched.

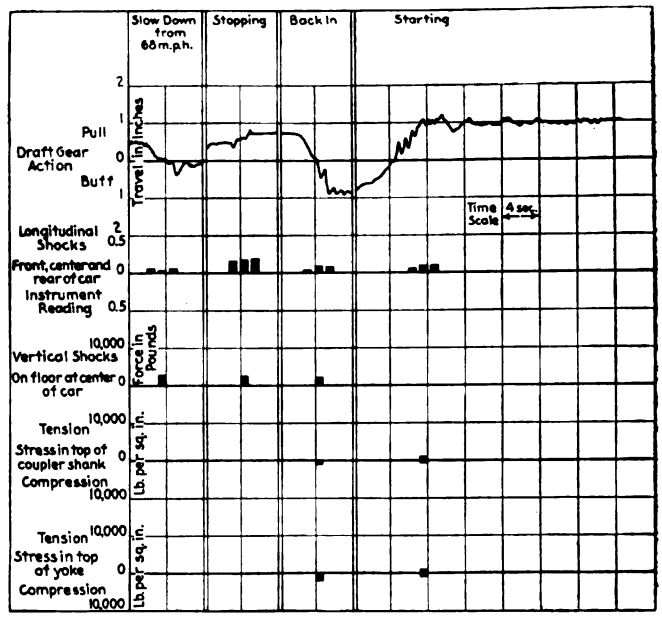
Small clamp plates containing screws were soldered to the coupler shank and the yoke at locations where it was decided to determine the strain. When a load or force was applied, a lengthening or shortening of the fibers occurred and the clamp plates were either drawn further apart or brought closer together which moved the scratch arm in the direction of the longitudinal axis of the gage an amount equal to the strain. At the same time there was a movement of the arm along the transverse axis caused by the spring tension in the arm at the lateral sliding friction being less than the static friction under the holder.

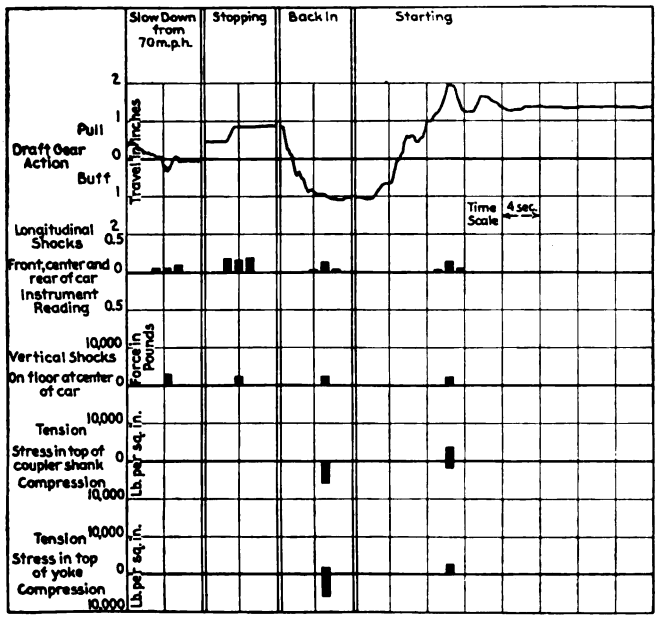
Upon the completion of the record, the target is removed from the holder for study under a microscope.

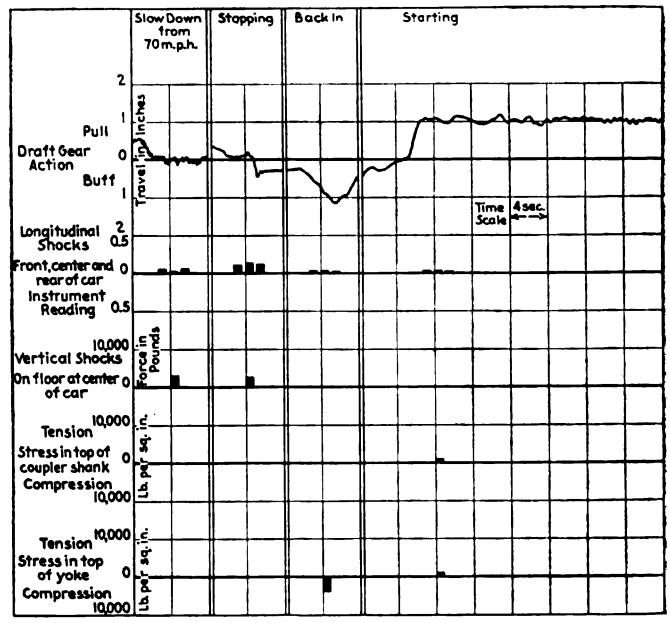

Slow Down from 65 m.p.h.
Stopping Train stretched out
Back In Bunching cars
Engine Brake Applied While backing, stretching cars
Starting Forward
Engine Brake Applied While running forward
Engine Starts Quickly Stretching cars
Pull
Draft Gear Action
Buff
Travel in Inches
Time Scale 4 sec.
Longitudinal Shocks
Front, center and rear of car
Instrument Reading
Vertical Shocks
On floor at center of car
Force in Pounds
Tension
Stress in top of coupler shank
Compression
Lb. per sq. in.
Stress in top of yoke

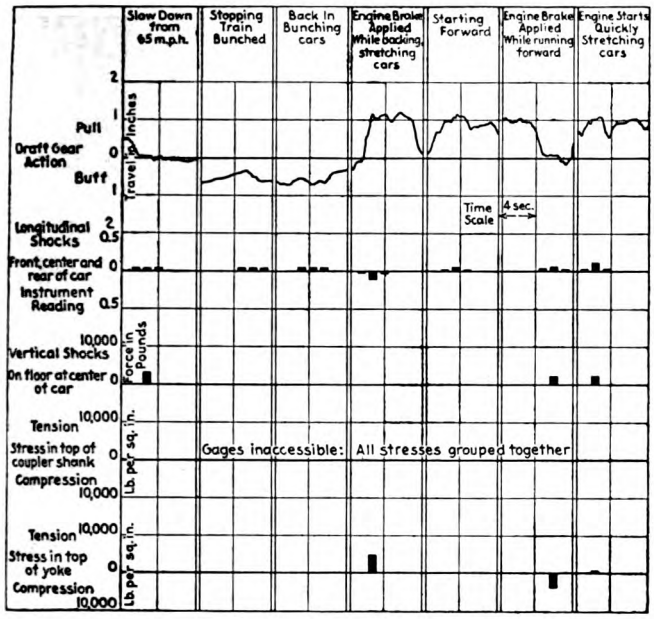

Slow Down from 66 m.p.h.
Stopping Train stretched out
Back In Bunching cars
Engine Brake Applied While backing, stretching cars
Starting Forward
Engine Brake Applied While running forward
Engine Starts Quickly Stretching cars
Pull
Draft Gear Action
Buff
Travel in Inches
Time Scale 4 sec.
Longitudinal Shocks
Front, center and rear of car
Instrument Reading
Vertical Shocks
On floor at center of car
Force in Pounds
Tension
Stress in top of coupler shank
Compression
Lb. per sq. in.
Stress in top of yoke


Slow Down from 68 m.p.h.
Stopping
Back In
Starting
Pull
Draft Gear Action
Buff
Travel in Inches
Time Scale 4 sec.
Longitudinal Shocks
Front, center and rear of car
Instrument Reading
Vertical Shocks
On floor at center of car
Force in Pounds
Tension
Stress in top of coupler shank
Compression
Lb. per sq. in.
Stress in top of yoke

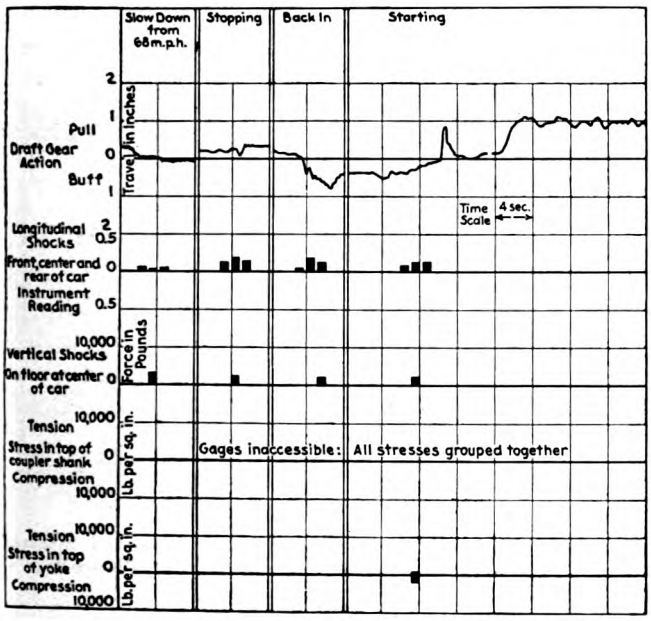

Slow Down from 68 m.p.h.
Stopping
Back In
Starting
Pull
Draft Gear Action
Buff
Travel in Inches
Time Scale 4 sec.
Longitudinal Shocks
Front, center and rear of car
Instrument Reading
Vertical Shocks
On floor at center of car
Force in Pounds
Tension
Stress in top of coupler shank
Compression
Lb. per sq. in.
Stress in top of yoke


Slow Down from 70 m.p.h.
Stopping
Back In
Starting
Pull
Draft Gear Action
Buff
Travel in Inches
Time Scale 4 sec.
Longitudinal Shocks
Front, center and rear of car
Instrument Reading
Vertical Shocks
On floor at center of car
Force in Pounds
Tension
Stress in top of coupler shank
Compression
Lb. per sq. in.
Stress in top of yoke

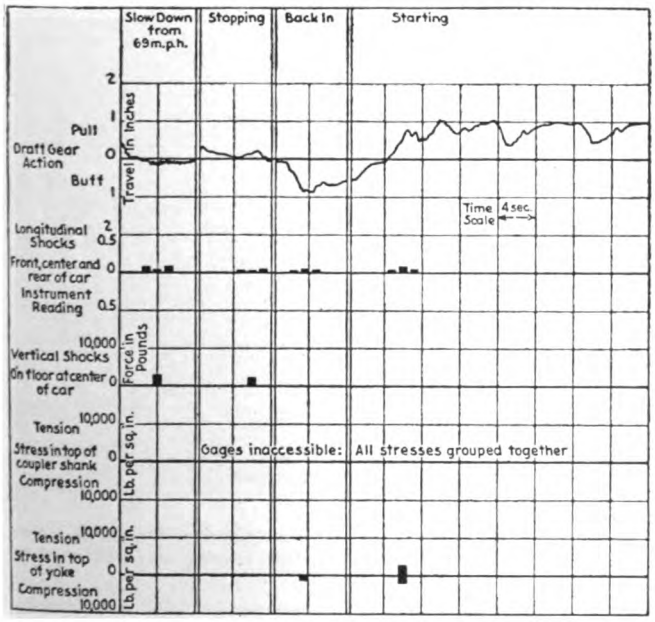

Slow Down from 70 m.p.h.
Stopping
Back In
Starting
Pull
Draft Gear Action
Buff
Travel in Inches
Time Scale 4 sec.
Longitudinal Shocks
Front, center and rear of car
Instrument Reading
Vertical Shocks
On floor at center of car
Force in Pounds
Tension
Stress in top of coupler shank
Compression
Lb. per sq. in.
Stress in top of yoke



Left to right: Fig. 5A—Friction gears; Fig. 58—Waughmat Twin Cushions; Fig. 5C—Waughmat Twin Cushions with Waughmat buffers—Al charts for normal stop and intentional rough start showing shocks and stresses in car No. 1 with standard couplers, on tangent track, 0.02 per cent grade, rails wet



Left to right: Fig. 6A—Friction gears; Fig. 6B Waughmat Twin Cushions; Fig. 6C—Waughmat Twin Cushions with Waughmat buffers—All charts for normal stop and start showing shocks and stresses in car No. 1 with standard couplers, on curve 0 deg. 22 min. right, 0.13 per cent grade, rails wet



Left to right: Fig. 7A—Friction gears; Fig. 7B—Waughmat Twin Cushion; Fig. 7C—Waughmat Twin Cushions with Waughmat buffers—All charts for normal stop and start showing shocks and stresses in car No. 1 with standard couplers, tightly locked, on curve 0 deg. 22 min. right, 0.13 per cent grade, rails dry

Since the abrasive tip of the marker arm carries many fine cutting particles, the target will have many duplicate records, Fig. 10, scratched upon its surface. The clearest of these is used for examination. The microscope is used to measure the scratches on either side of the base line. Knowing the gage length and the length of the scratches, the strain per inch can be determined, from which the stress in pounds per square inch is computed.

Other test equipment included stop watches, a signal system, pressure gages, telephone communication between the locomotive cab and the test cars, and a motion picture camera.

Eighteen different locations between Albany and Utica were selected at which definite events would occur such as stopping, starting, slow down, etc. These operations were performed at the same place and in the same manner by the same engine crew throughout the tests.

Most of the test data has been inspected and much of it has been compiled. Charts have been drawn showing the draft-gear action and the accompanying shocks and stresses for friction draft gears, Twin Cushions with and without Waughmat buffers, and other arrangements, covering the entire test section of 95 miles. A few of the many charts are shown in Figs. 5 to 7.

Each of the charts has five divisions of data: (1) Draft-gear travel in inches; (2) longitudinal shocks at the front end, center, and rear end of the test car; (3) vertical shocks at the center of the test car; (4) stresses in the coupler shank, and (5) stresses in the draft-gear yoke. Each inch of chart from left to right of the draft-gear record shows four seconds of action. Having the amount of draft-gear travel, above or below the base line, and the time scale, the rate of travel in inches per second may easily be computed.

Fig. 5A, friction gears, shows much higher stresses than does Fig. 5B, Twin Cushions, while shocks are still lower in Fig. 5C when Waughmat buffers are added.

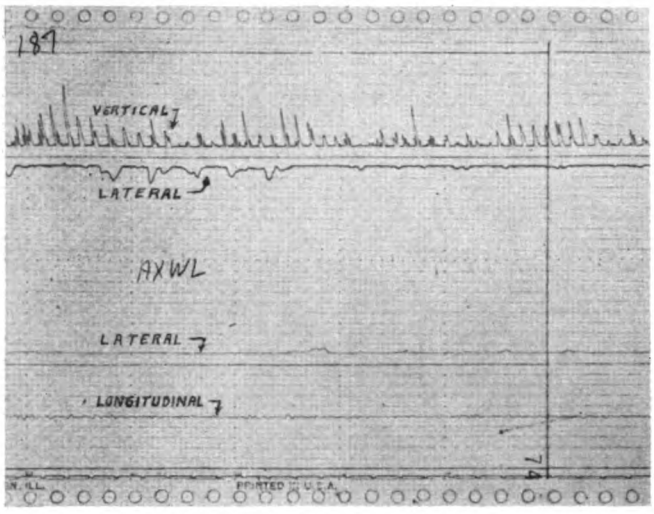


Fig. 8A—Vibrations with friction gear and standard couplers while free running at 70 m.p.h.

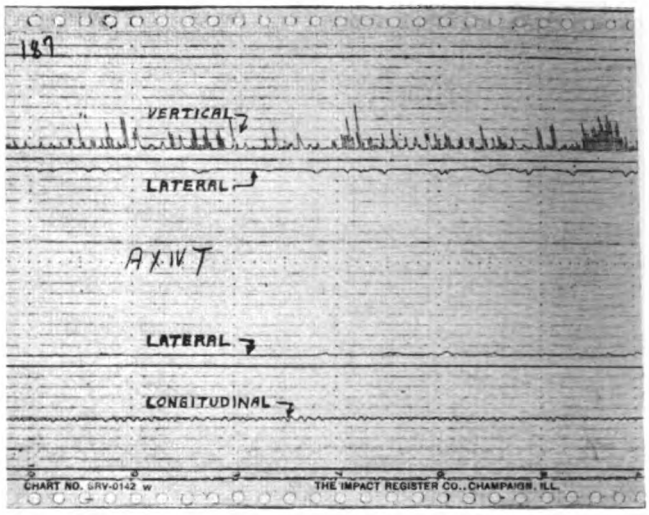


Fig. 9A—Vibrations with friction gear and standard couplers tightly locked while free running at 60-70 m.p.h.

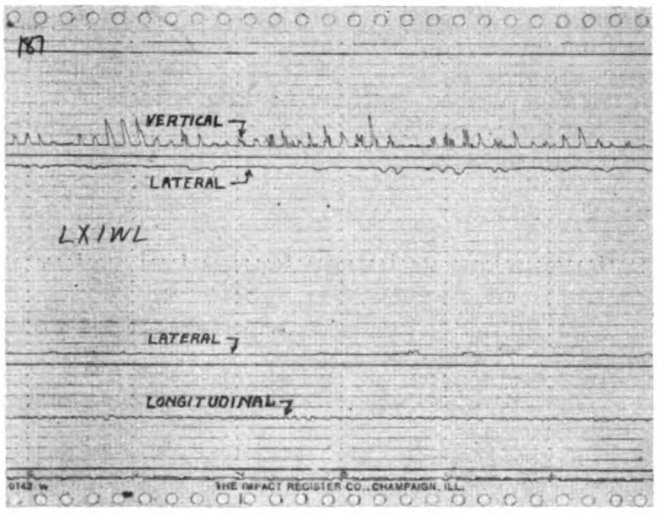


Fig. 8B—Vibrations with Waughmat Twin Cushion and standard couplers while free running at 70 m.p.h.

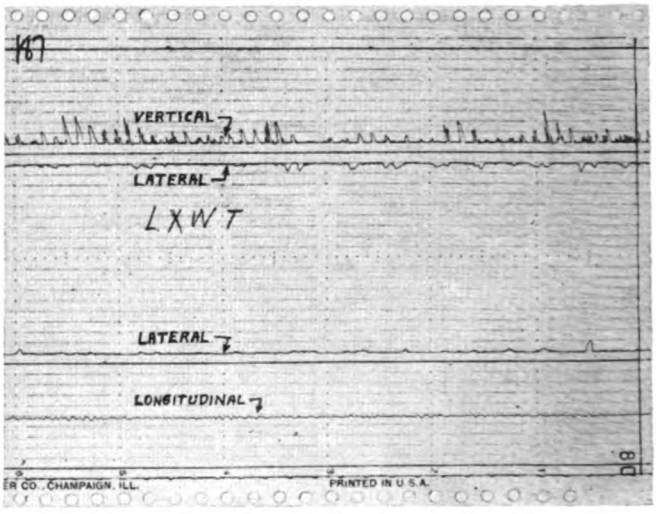


Fig. 9B—Vibrations with Waughmat Twin Cushion and standard couplers tightly locked while free running at 60-70 m.p.h.

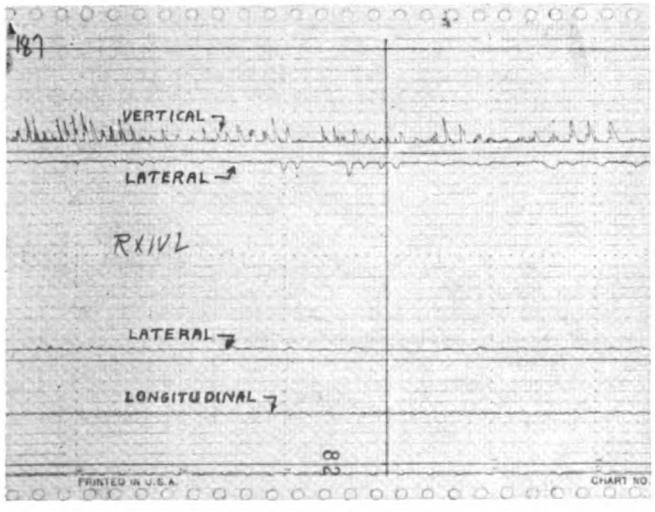


Fig. 8C—Vibrations with Waughmat Twin Cushion, Waughmat buffers, and standard couplers while free running at 70 m.p.h.

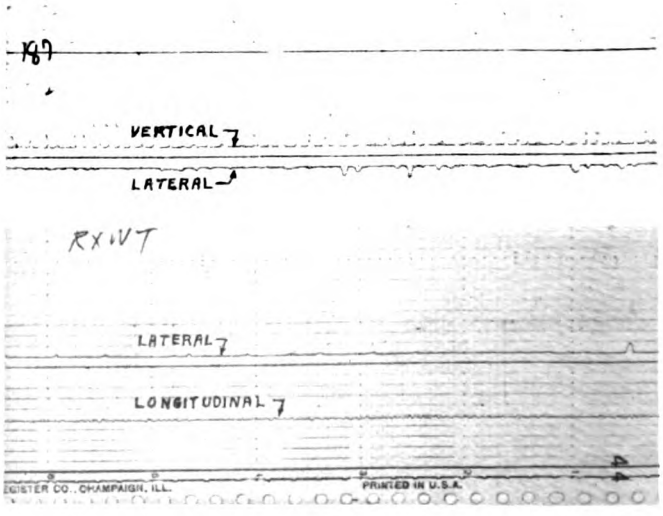


Fig. 9C—Vibrations with Waughmat Twin Cushion, Waughmat buffers, standard couplers tightly locked, free running at 60-70 m.p.h.

Figs. 8 and 9—Typical three-way recorder charts

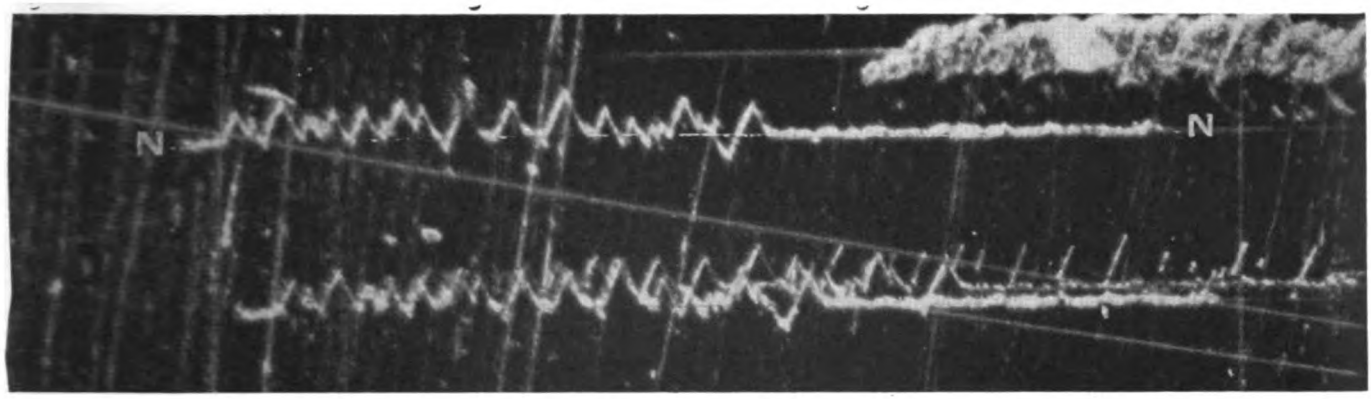


Fig. 10—Portion of typical strain-gage record magnified 300 times

Figs. 6 and 7 are graphs of action at the same location, mile post 180, the only difference being that in Fig. 6 the couplers were standard while in Fig. 7 the coupler knuckles were tightly wedged by means of a rod and turnbuckles, thus simulating tight-lock coupler effects. It is seen that there is a reduction in the magnitudes of the shocks and stresses when tightly locked couplers are employed with friction gears. A comparison of Figs. 7A and 6B with Fig. 6A shows that there is about the same amount of reduction in shocks and stresses when Twin Cushions are employed as for tightly locked couplers. In other words, Twin Cushions and tightly locked couplers perform somewhat the same function in reducing the shocks of train operations.

Train-handling operations were illustrated in Figs. 5 to 7. Records of the free running of the train are illustrated in Figs. 8 and 9. The shocks or vibrations in three directions, vertical, lateral, and longitudinal, are shown for mile post 187. Twin Cushions show much lower vertical and lateral shocks than do friction gears, Fig. 8A.

The employment of tightly locked couplers likewise reduces the magnitudes of the vertical and lateral shocks as shown by a comparison of Figs. 8A and 9A. However the frequency of vertical shocks or vibrations is slightly increased. Attention is called to the group of closely-spaced vertical vibrations of Fig. 9A. This is one of the many cases of momentary up-and-down vibrations of the car for this gear arrangement. If prolonged or repeated, it is very disturbing to the passengers. It is due to the frequency of the applied forces coinciding with the natural period of the vertical vibration of the spring system of the car. The number of vertical vibrations in the group indicated is 8.86 per second. By additional subsequent tests the natural period of vibration of this car was found to start at 8.75, to reach a maximum at about 9.27, and to be past the resonance period at 9.79 cycles per second. Hence, the natural frequency of the car and the frequency of the applied forces are seen to coincide. When the two coincide, poor or unpleasant riding is the result. For friction gears with standard couplers, Fig. 8A, the number of vibrations, or frequency, at this point on the track was only 7.50 per second. Thus, the use of tightly locked couplers increased the frequency only slightly, 7.50 to 8.86 cycles per second, but sufficiently to bring it into the range of disagreeable action. This condition can be changed either by making the spring system of the trucks slightly less stiff, or by damping the applied forces by the use of such equipment as Twin Cushions or Waughmat buffers. See Figs. 9B and 9C. Rubber, as everyone knows, is an excellent material to dampen shocks and vibrations. The advantages of tightly locked couplers are greater when used in conjunction with Twin Cushions, with or without Waughmat buffers.

Summary of Data and Conclusions

The highest shocks were found to occur when a change in the direction of the cars takes place, such as starting after having backed in. An examination of many actions illustrates the apparent reason why the rate of draft-gear action is often high for gears that can act in only one direction at a time. When the direction of travel of the car has been in one direction, the draft gear will be compressed corresponding to that condition. Upon a reversal of direction of the motion of the car, the car must move the amount the draft gear has been compressed before the gear can again offer any resistance to the energy being applied to the car. This lack of control, usual in a one-way action draft gear, results in a rapid rate of draft-gear action and consequent high shocks to the car.

The rate of travel in inches per second must be controlled. The energy applied to move the cars should be applied at a comparatively uniform rate rather than suddenly. Twin Cushions, actually two gears, do this, as is shown in the charts submitted.

Under the conditions of free running the test data show that all the various arrangements of draft gears and buffers give smooth longitudinal action. Prior to the tests it was not expected that any draft gear would greatly reduce lateral or vertical shocks. It was considered that the control of lateral shocks was more a function of equipment such as tight-lock couplers than draft gears. Similarly, it was thought that the spring system of the truck governed vertical action. However, the tests show that Twin Cushions greatly reduce both lateral and vertical shocks.

Tightly locked couplers, under the conditions of free running, greatly reduce lateral shocks, but increase the frequency of vertical shocks and vibrations.

The results of the tests suggest the following method for improving the riding qualities of passenger cars. If a car is observed to be vibrating or oscillating in any direction while running, determine the frequency of that vibration by the use of a three-way shock recorder or other instrument. Determine the natural period of vibration of the car, or one of that series of cars, in the vertical, lateral, longitudinal, and torsional planes. If the frequency during running coincides with the natural frequency of the car, commonly called resonance, change the truck spring system slightly so as to change the natural frequency or employ a damping medium such as Twin Cushions or Waughmat buffers to break up or prevent resonance. By preventing resonance, the riding qualities of the car will be improved.

A Study of

The Locomotive Boiler*

By C. A. Brandt †

The effect of the absorption efficiency, grate area, front-end design, superheater, and feedwater heating on the efficiency and capacity of the boiler

Absorption Efficiency of the Heating Surfaces

The absorption efficiency of the surfaces should be expressed as the total heat absorbed in per cent of the total heat available for absorption; that is, of the total heat drop from the furnace temperature to the metal temperature of the flues and superheater units at the smokebox. This is termed the true efficiency and is very high, about 90 per cent in a locomotive boiler, due to the high gas velocity and the cooling of the gases to within 75 deg. F. of the temperature of the water at low rating, and 200 deg. F. at high capacity.

On locomotives with Type E superheaters the smokebox gases are from 100 to 150 deg. F. lower than the steam temperature. The losses due to the sensible heat escaping in smokebox gases range from 19 to 25 per cent of the heat in the coal fired, at high rating, and the only hope of reducing these is by a radical change in the boiler design whereby the average temperature head could be increased by the use of a counterflow economizer. In this manner the smokebox gases could be lowered some 210 deg. F. which would give a 7 per cent increase in the over-all boiler efficiency.

The importance of an effective arrangement of the flue heating surfaces is most apparent at high capacity when 70 per cent of the liberated heat is delivered to the flues. The ratio of the net gas area of a flue to its gas-swept perimeter (sometimes called hydraulic depth) determines the gas-carrying capacity of the flues. The larger this ratio becomes the more gas will flow for an equal pressure drop. This has been labeled the "flue capacity factor," or *F. C. F.*

The longer a flue of a given *F. C. F.* is made, the greater becomes its true efficiency and also its draft loss. Now if the length of the flue in inches is divided by the *F. C. F.* a value is obtained which expresses the true efficiency of any diameter and length of flue. This factor has been termed the "flue efficiency factor" or *F. E. F.* The larger it becomes the more efficient a flue is. In Fig. 10 has been plotted a curve showing the true efficiency that will be obtained on any size and length of flue with a given flue efficiency factor, or *F. E. F.;* that is, the ratio of length to hydraulic depth.

In Fig. 10 is also shown the true efficiency of several sizes of flues for different lengths. The *F. E. F.* for a 2-in. inside-diameter flue 18 ft. long is 432 and gives a true efficiency of 88 per cent. If this flue is made 25 ft. long the *F. E. F.* becomes 600 and the true efficiency is increased to 94.5 per cent, but the draft loss is increased in the same ratio as the length. In America many boilers have been built with flues 22 to 25 ft. long, but usually efforts are made to keep the flue lengths down by lengthening the combustion chamber where this can be done. It is evident from Fig. 10 that a larger-diameter flue of a greater length can be used to give the same true efficiency as a smaller flue of shorter length.

* Part II of a paper presented on December 7, 1939, at the annual meeting of the American Society of Mechanical Engineers, at Philadelphia, Pa. Part I appeared in the January, 1940, issue.

† Chief engineer, The Superheater Company.

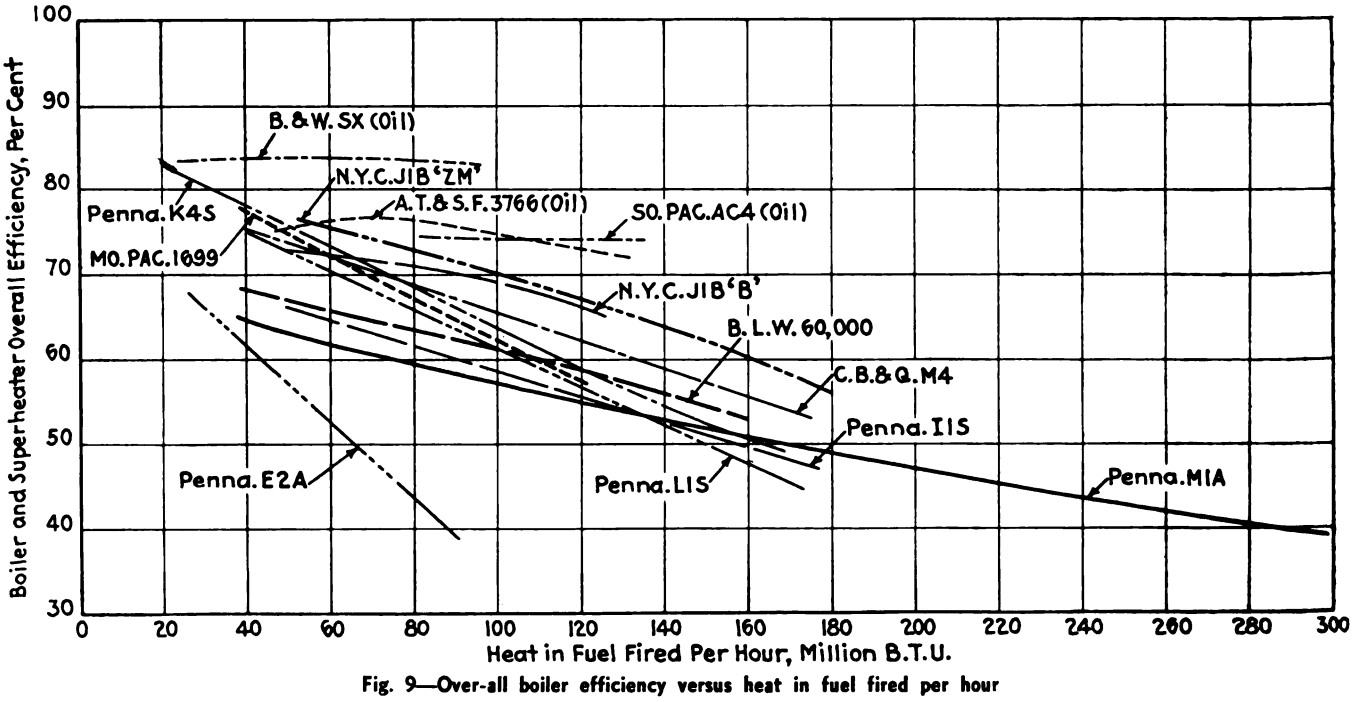


Fig. 9—Over-all boiler efficiency versus heat in fuel fired per hour

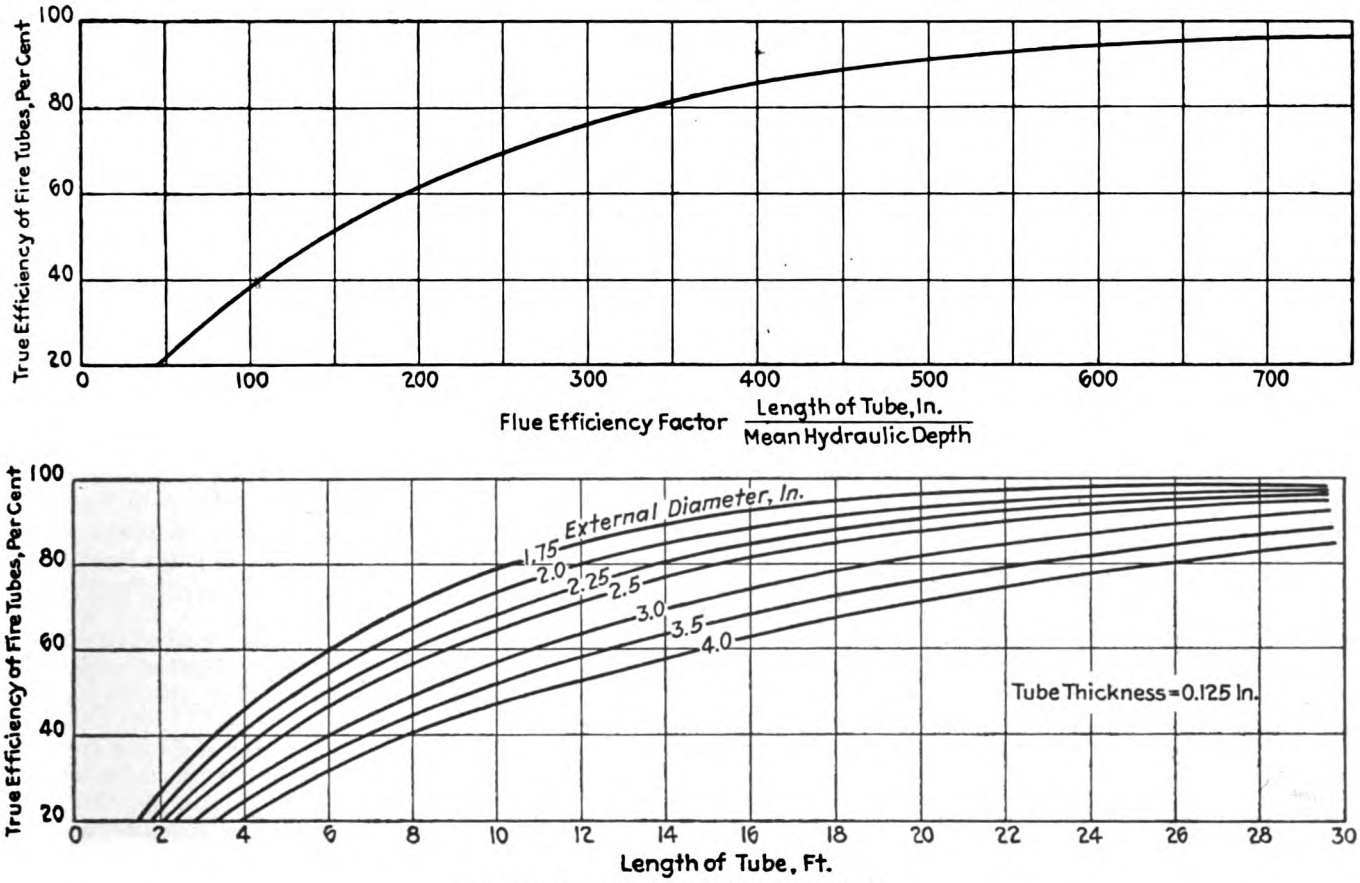


Fig. 10—True absorption efficiency of flues

The heat-absorption efficiency of locomotive boilers increases with an increase in the flue efficiency factor of the tubes and flues and ranges usually between 78 and 88 per cent. The absorption efficiency of several boilers has been shown in Fig. 11. It is noted that there is a very small decrease in this efficiency as the rate of firing is increased.

The combined absorption and combustion efficiency gives the over-all efficiency of the boiler and superheater and these data are shown in Fig. 9 for the engines previously cited. The general proportions and boiler ratios of all the engines shown in this and previous curves are given in Tables I to VI. Heat balances showing the heat absorbed by the boiler and superheater together with the various heat losses for two modern locomotives are shown in Figs. 12 and 13.

Before leaving the subject of heat absorption, a few words may be said as to the heat-absorbing capacity of the firebox. Cole proposed 55 lb. of steam generated per sq. ft. of heating surface per hour as the maximum based on Professor Goss's test at Coatesville, the only test made on a locomotive where the firebox evaporation was determined separately. This value of evaporation rate has continued to be used up to now even though the size of the locomotive firebox has increased five to six times since the Coatesville tests. It is reasonable to suppose that the same evaporation rates cannot very well apply to a firebox with 800 sq. ft. of heating surface

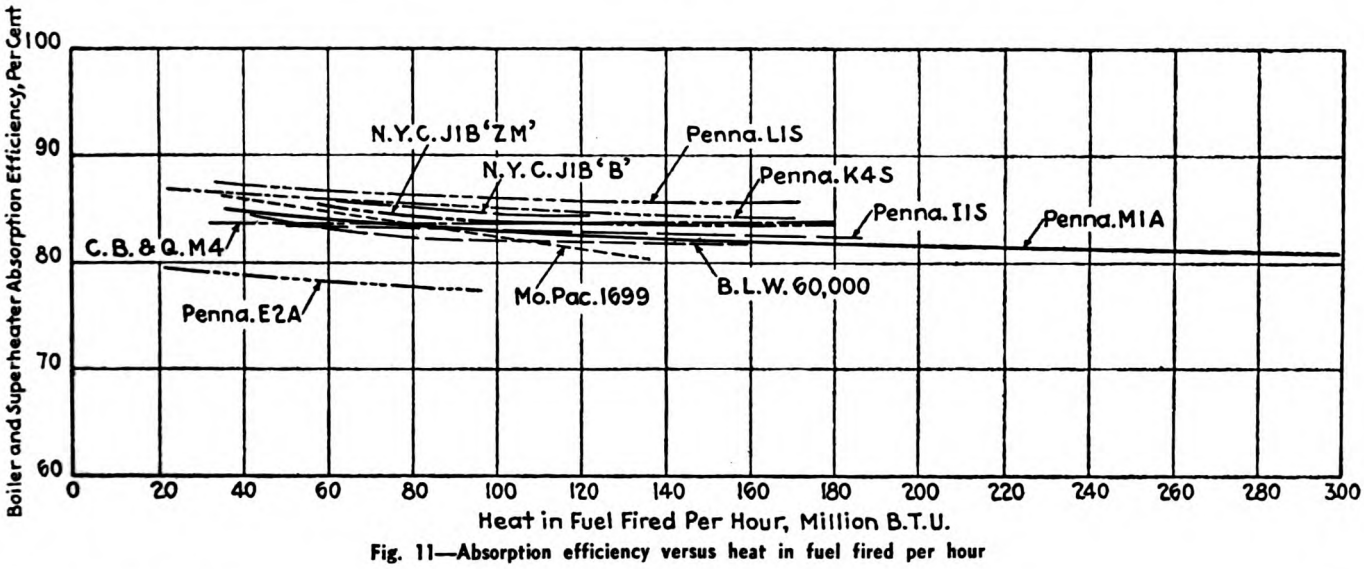


Fig. 11—Absorption efficiency versus heat in fuel fired per hour

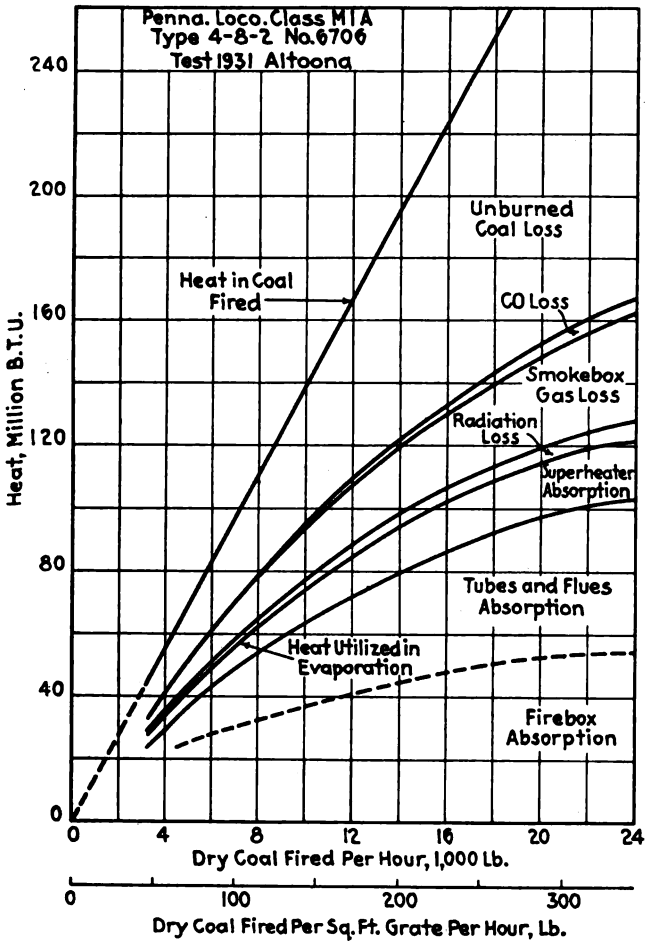


Fig. 12—Heat balance versus dry coal fired per sq. ft. of grate per hour; Pennsylvania class M1A

having syphons, circulators, etc., as to a firebox with only 150 sq. ft. of heating surface.

Since the adoption of waterwalls in stationary boilers, the heat absorption due to radiant heat has received much attention and analysis. The general behavior of radiant energy as expressed and defined in Stefan-Boltzmann's law, Prevost's law, Kirchhoff's law, Planck's formula, and studies by many other investigators, permits definition and determination of the coefficients of emission, absorption, reflection, and transmission of radiant heat. To apply these laws to locomotive fireboxes, additional test data will be required.

The proportion of the total heat liberated in the furnace, which is absorbed by the firebox heating surfaces has been termed "furnace absorption efficiency," and this determines the temperature of the combustion gases as they leave the firebox. An accurate knowledge of this temperature is important as it determines the design and performance of the superheater.

In tests where complete gas analyses have been made to determine the quantities of air used for combustion, it is possible to calculate the per cent of fuel fired that is actually burned and the total heat liberated in the furnace. A fraction of the liberated heat is absorbed by the firebox and the balance leaves as sensible heat in the combustion gases which, with the total known weight of gases, determines the mean temperature of these gases leaving the furnace. The furnace absorption efficiency can thus be stated in terms of the average temperature of the gases leaving the furnace.

Thus, if

t_1 = temperature of combustion gases leaving firebox, deg. F.

C_P = mean specific heat of combustion gases between t and 60 deg. F.

H_T = total heat liberated in firebox per lb. of combustion gases

H_g = heat in 1 lb. of combustion gas leaving furnace

H_F = heat absorbed in firebox, per cent of total liberated

then

$$H_g = C_P(t_1 - 60)$$

and the per cent of total heat liberated in the firebox that leaves the furnace in the gas is equal to

$$C_P \frac{(t_1 - 60)}{H_T} \times 100$$

The furnace absorption efficiency, therefore, is

$$H_F = \left[1 - \frac{C_P(t_1 - 60)}{H_T}\right] \times 100$$

The relation between the percentage of heat absorbed by the firebox and the temperature of gases leaving, depends upon the heat liberated per lb. of combustion gas, which again depends upon the excess air used for combustion. If, therefore, an accurate measure of the gas temperature leaving the firebox is obtained with a reliable pyrometer the furnace absorption efficiency can be determined.

It has been demonstrated that the radiation from the flames is largely due to incandescent particles of fuel and ash in the flame. The quantity and distribution of this radiating material in the flames, together with the amount of firebox heating surface, determine the coefficient of emission or absorption. This explains why boilers fired with oil give higher superheat; the less luminous flames of the oil fire will give up a smaller percentage of heat to the firebox by radiation, and the gases entering the flues are therefore hotter.

Several formulas have been proposed for the determination of the furnace absorption efficiency. The author has checked a number of the formulas proposed by Hud-

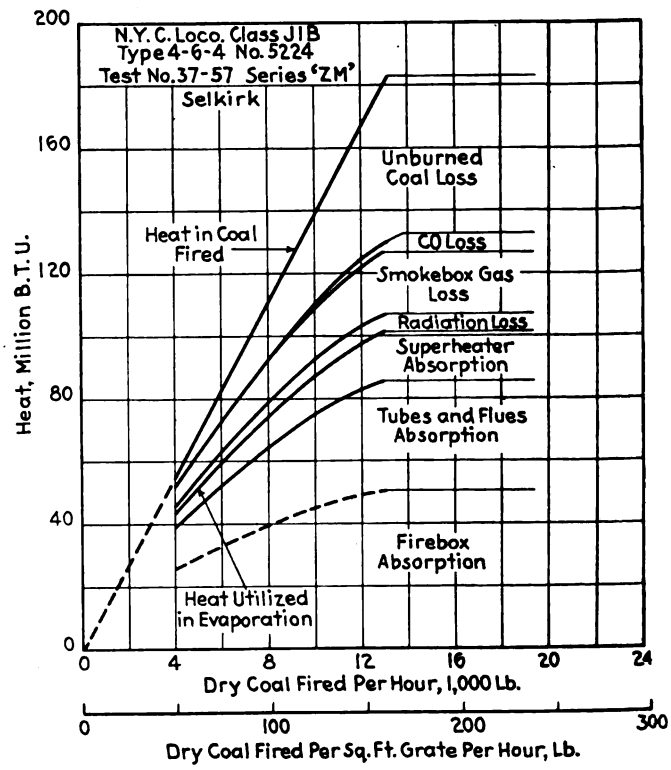


Fig. 13—Heat balance versus dry coal fired per sq. ft. of grate per hour; New York Central class J1B

son, Broido, Wohlenberg, Orrok, Munzinger, Bottomly, and Adloff, but sufficient test data are not available to conform their methods closely enough for locomotive-firebox conditions. All formulas, however, show that the fraction of the total heat liberated, which is absorbed as radiant heat by the furnace walls, decreases as the total heat liberation is increased. It will range from about 50 to 55 per cent at low rating down to perhaps 25 to 30 per cent at high-capacity operation.

At low rating the heat absorption per square foot of firebox heating surface will be near the figure commonly used, or 55 lb. of water evaporated per sq. ft. but at high capacity the heat absorption will approach a figure of 125 lb. of water per sq. ft. of heating surface. From the studies made of this problem, it is doubtful if the percentage of heat absorption can be increased to much more than 50 to 55 per cent of the heat liberated by increasing the amount of firebox heating surface, because the amount of radiant energy absorbed is limited by the effective surfaces of the fire bed and the luminosity of the flames.

Grate Area in Relation to Efficiency and Capacity

The size of the grate area should be in proportion to the maximum output expected of the boiler and the quality of the coal to be burned. With the exception of the Dakota and Wyoming lignites, the average maximum variation in the heating value of the coals mined east of the Mississippi is from 12,000 to 14,000 B. t. u. per lb., and west of the Mississippi from 10,000 to 12,000 B. t. u. per lb., or about 17 per cent for each class of coal.

If the grate-area ratios of modern locomotives, however, are studied it will be noted that they vary to a much greater extent than the heating value of the fuel, as shown in the table.

Variations in Grate-Area Ratios

	Ratio		Range of Difference, per cent
	Minimum	Maximum	
Grate area per 1,000 lb. tractive force	0.78	2.32	1:2.97
Grate area per sq. ft. total heating surface	0.0119	0.0262	1:2.20
Grate area per sq. ft. firebox heating surface	0.101	0.353	1:3.50
Grate area per sq. ft. net gas area	7.1	13.8	1:1.94

It would appear that much thought and study must be given to this subject as the proper size of grate area is important in obtaining high furnace efficiency and capacity. If too small a grate is selected, the firing rate will be too high at maximum-capacity operation and, if too large, it is difficult to keep the grate covered at low capacity, which results in bare spots, a high per cent of excess air, and a reduction of boiler efficiency and superheat. The service condition and the profile of the road must be carefully analyzed for best results.

The question of the percentage of air openings through the grates has been explored during the last few years. Recent tests on one railroad, where grates with air openings of 10, 24, and 32 per cent were tried, indicated a very small variation in boiler efficiency between the various percentages of air openings, or less than 1½ per cent above and below the mean percentage.

The relation between equivalent evaporation per square foot of grate area and coal fired per square foot of grate area per hour has been plotted in Fig. 14.

Secondary Air for Combustion

The length of the firebox and the combustion chamber is of importance, but there is a question whether the function of the latter which gives it its name is operative,

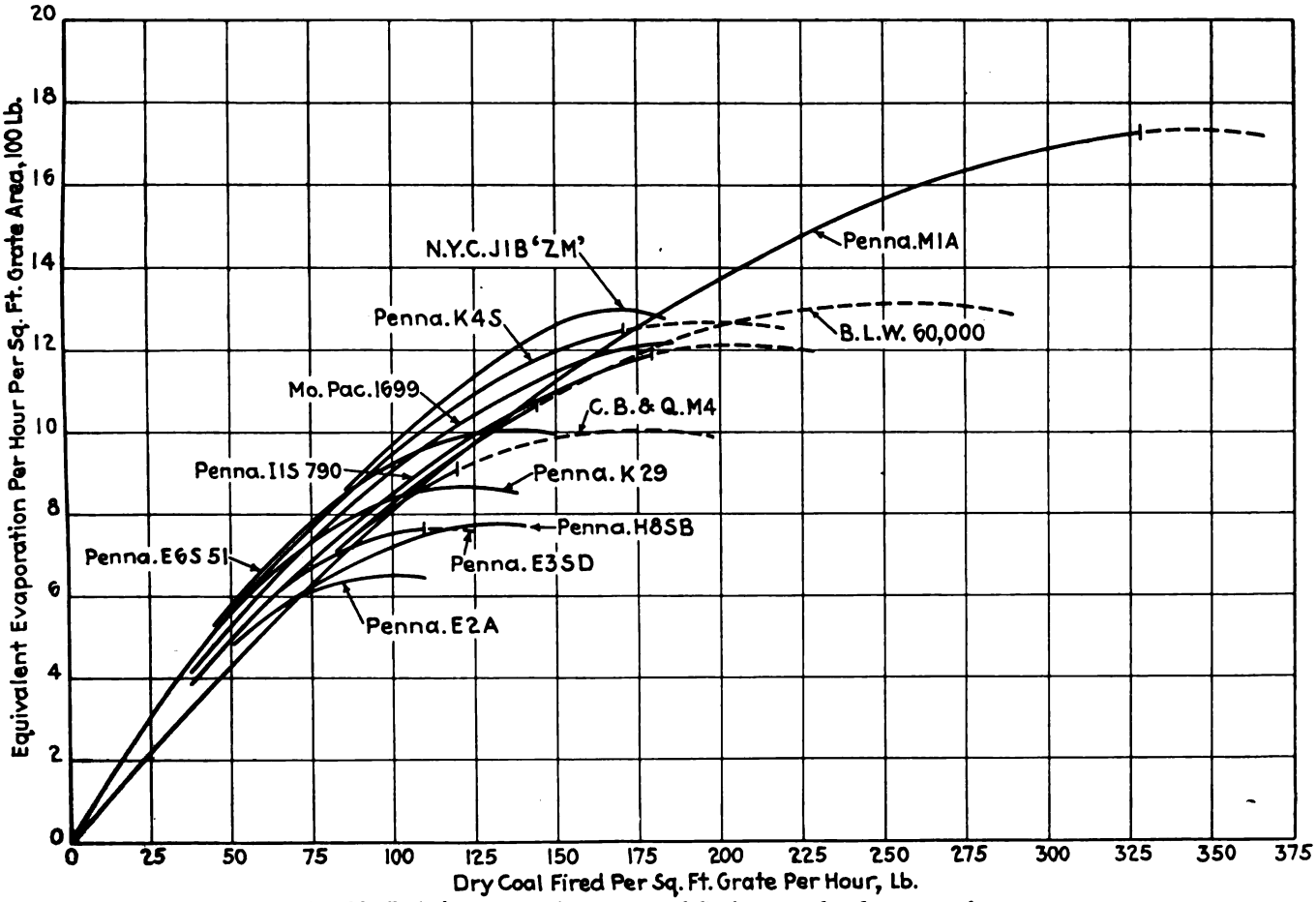


Fig. 14—Equivalent evaporation versus coal fired per sq. ft. of grate per hour

Table IV—General Dimensions and Boiler Ratios of Eight-Coupled Locomotives

1 Type	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4	4-8-4	4-8 2
2 Railroad	D. L. & W.	C. M. St. P. & P.	C. B. & Q.	C. M. St. P. & P.	Can. Pac.	L. V. T3	R. F. & P.	Nor. Pac.	U. P.	P. R. R. M1A
3 Road class	1631-1650	S1	O5	S2	K1	5129	551-555	A3	800-819	6706
4 Date built	1934	1930	1938	1937	1928	1935	1936	1938	1937	1931
5 Boiler pressure, lb. per sq. in.	250	230	250	285	275	275	275	260	300	250
6 Cylinder diameter and stroke, in.	28X32	28X30	28X30	26X32	25½X30	27X30	27X30	28X31	24½X32	27X30
7 Driving wheels, diameter outside tires, in.	74	74	74	74	75	77	77	77	77	72
8 Weight on drivers, lb.	274,000	258,814	282,700	282,320	249,000	270,100	277,245	294,000	270,000	271,000
9 Total weight of engine, lb.	447,000	450,838	465,300	490,450	423,000	441,440	466,040	491,800	465,000	390,000
10 Tractive force, lb.	72,000	60,000	67,500	70,800	60,800	66,500	66,500	69,800	63,600	64,550
11 Boiler diameter, first course, inside, in.	84¼	86⅝	86½	90⅝	82½	84⅜	86	86⅜	86⅝	82
12 Boiler diameter, largest, outside, in.	95	100	100	100	96½	98¼	98¼	99	100	96
13 Length over tube sheets, ft.-in.	21-6	21-0	21-0	21-0	20-6	21-6	21-0	19-6	20-6	19-1
14 Combustion-chamber length, in.	66⅛	60	40	72	60	48	78	90½	72	98
15 Grate area, sq. ft.	88.2	103.0	106.5	106.0	93.5	96.5	96.3	115.0	100.2	70
16 Tube and flue heating surface, sq. ft.*	4,992	4,860	4,804	4,931	4,509	4,932	4,827	4,202	4,118	4,303
17 Firebox heating surface, sq. ft.*	496	540	433	578	422	507	551	553	479	403
18 Total evaporative heating surface, sq. ft.*	5,488	5,400	5,237	5,509	4,931	5,439	5,378	4,755	4,597	4,706
19 Superheater surface, steam side, sq. ft.	2,180	2,403	2,300	2,236	2,112	2,056	2,130	2,026	1,458	1,630
20 Firebox volume, cu. ft.	534	630	650	700	620	540	640	812	675	475
21 Gas area through boiler, sq. ft.	10.20	10.30	10.15	11.10	9.86	10.05	10.05	10.18	9.67	9.71
22 Type of superheater	E	E	E	E	E	E	E	E	A	E
23 Steam area through superheater, sq. in.	67.7	76.9	72.4	77.3	69.0	67.7	69.1	75.3	66.0	56.4
24 Maximum evaporation, calculated, lb. per hr.	76,905	79,050	72,160	82,000	69,140	76,990	79,385	75,280	68,700	67,850
25 Maximum evaporation, on test, lb. per hr.										99,095
26 Flues, number and diameter, in.	202-3½	218-3½	218-3½	201-3¾	196-3½ 59-2¾	202-3½	205-3½	186-3¾	58-5½	170-3½
27 Tubes, number and diameter, in.	82-2¼	56-2¼	51-2¼	66-2¼	7-3½	77-2¼	73-2¼	58-2¼	201-2¼	120-2¼
28 Superheater units, number and diameter, in.	102-1⅝	109-1⅝	109-1⅝	102-1¼	98-1⅝	102-1⅝	104-1⅝	94-1¼	58-1½	85-1⅝
29 Gas area per 1,000 lb. tractive force, sq. ft.	.142	.172	.151	.157	.162	.151	.151	.145	.152	.151
30 Gas area per sq. ft. of grate, sq. ft.	.115	.100	.095	.105	.105	.104	.104	.089	.097	.139
31 Gas area per sq. ft. of tube and flue heating surface, sq. ft.	.00204	.00212	.00211	.00225	.00219	.00204	.00208	.00242	.00235	.00226
32 Grate per 1,000 lb. tractive force, sq. ft.	1.23	1.72	1.58	1.50	1.54	1.45	1.45	1.65	1.58	1.09
33 Grate per sq. ft. total evaporative heating surface, sq. ft.	.0161	.0191	.0204	.0192	.0190	.0177	.0179	.0242	.0218	.0149
34 Firebox volume per 1,000 lb. tractive force, cu. ft.	7.42	10.50	9.63	9.90	10.20	8.12	9.63	11.67	10.60	7.35
35 Firebox volume per sq. ft. of gas area, cu. ft.	52.4	61.1	64.0	63.1	62.8	53.8	63.7	79.5	69.8	49.0
36 Firebox volume per sq. ft. of grate, cu. ft.	6.05	6.11	6.10	6.60	6.63	5.60	6.67	7.06	6.75	6.80
37 Firebox volume per sq. ft. total evaporative heating surface, cu. ft.	97.2	116.0	124.0	127.1	126.0	99.3	119.0	171.0	147.0	101.0
38 Firebox heating surface per sq. ft. of grate, sq. ft.	5.64	5.24	4.06	5.46	4.52	5.26	5.72	4.80	4.79	5.75
39 Firebox heating surface per sq. ft. total evap. heating surface x 100 sq. ft.	9.03	10.00	8.27	10.50	8.56	9.34	10.25	11.60	10.42	8.55
40 Total evap. heating surface per 1,000 lb. tractive force, sq. ft.	76.2	90.0	77.5	77.8	81.1	81.6	81.0	68.1	72.3	72.8
41 Total evap. heating surface per sq. ft. of grate, sq. ft.	62.2	52.4	49.2	52.0	52.7	56.4	56.0	41.4	46.0	67.2
42 Superheat. surface per sq. ft. total evap. heat. surface, sq. ft.	.398	.445	.440	.406	.427	.378	.396	.422	.317	.346
43 Gas area through flues, per cent	82.2	88.0	89.2	87.0	82.8	83.2	84.0	87.8	55.5	73.0
44 Weight on drivers per 1,000 lb. tractive force, lb.	3,800	4,315	4,185	3,990	4,090	4,065	4,170	4,220	4,250	4,200
45 Total weight of engine per 1,000 lb. tractive force, lb.	6,210	7,515	6,890	6,930	6,960	6,650	7,010	7,040	7,320	6,040

*Water side.

as there is no air admitted ahead of the arch on most locomotives to permit the carbon to burn completely in its passage through the combustion chamber.

Today, most modern locomotives in America are fired with a stoker which distributes the crushed coal with steam jets through the boiler backhead. The coal is thus thrown into the firebox through and against the gas stream at the point of its highest velocity. The heaviest coal lumps fall on the grate, but many of the fine coal particles are caught in the high-velocity gas stream and partially burned in suspension while traveling at high speed. During the short time the coal particles pass through the furnace, they must be heated to ignition temperature, the moisture driven off, and the volatile gas distilled and burned before the solid carbon is consumed. It is quite possible that most of the carbon now escaping could be completely burned in the large fireboxes if sufficient oxygen were admitted into the firebox and combustion chamber as secondary air. The beneficial effect of admitting secondary air above the fuel bed has been known for many years and recognized by authorities on combustion as very desirable, yet little has been done.

This subject was investigated by Henry Kreisinger[9] as early as 1917. In these tests it was proved that, with a firing rate up to 185 lb. per sq. ft. of grate and with the thickness of fuel bed varying from 6 to 12 in., all the oxygen in the air which entered through the grate and fuel bed was consumed at the level of approximately 4 in. above the grate.

A sufficient quantity of secondary air admitted above the fuel bed in such a manner as to create a turbulence in the gases would permit of an intimate mixing of the hydrocarbons thrown off by the coal, and provide the necessary oxygen for the complete combustion of volatile gases and carbon. Another very important result from the use of a correct amount of secondary air is that it will help to eliminate smoke which always has been a serious nuisance in locomotive-boiler operation.

Kreisinger states in his report,[9] "the ratio between the weight of air supplied and the weight of fuel gasified remains practically constant at about 7 to 1 so that only about one-half of the 15 pounds of air required to burn the fuel should be supplied through the fuel bed. In order to complete the combustion of all the fuel fed into the furnace, the balance of the air should be admitted above the fuel bed to consume the volatile, as well as fixed carbon present in this zone, or it will escape unburned."

Any scheme to admit secondary air above the fire should be arranged so that the air is controlled in accordance with the demand, in order to keep the excess air at a minimum and not decrease the fuel-burning capacity of the furnace or decrease the over-all boiler efficiency by too much excess air. Several schemes have been prepared to admit secondary air above the fire. The simplest is that of applying air-inlet thimbles in the sides of the firebox and the effectiveness of this should be fully explored. Some studies have been made of the introduction of preheated air by means of blowers. Actual tests have been conducted on one railroad by using blowers without air preheating, but so far no definite advance has been made. It is possible that the cost of such a scheme

[9] "Combustion of Coal and Design of Furnaces," by Henry Kreisinger, C. E. Augustine, and F. K. Ovitz, Bulletin No. 135, United States Bureau of Mines, Washington, D. C., 1917.

Table V—General Dimensions and Boiler Ratios of Eight-Coupled Locomotives

1	Type	4-8-4	4-8-4	4-8-4	4-8-4	6-4-4-6	4-6-2	2-8-2	4-4-2	2-8-2	4-8-4
2	Railroad	Gt. Nor.	Sou. Pac.	A. C. L.	A.T.&S.F.	P. R. R.	P. R. R. K-4-S	P. R. R. L-1-S	P. R. R. E-2-A	Mo. Pac.	U. P.
3	Road class	S-2	G-S-3	R-1	3765	S-1	1737	1752	5266	1699	820-834
4	Date built	1930	1937	1938	1938	1939	1914	1914	1904	1925	1939
5	Boiler pressure, lb. per sq. in.	225	280	275	300	300	205	205	205	200	300
6	Cylinder diameter and stroke, in.	29X29	26X32	27X30	28X32	4-22X26	27X28	27X30	20½X26	2-23X32	25X32
7	Driving wheels, diameter outside tires, in.	80	80	80	80	84	80	62	80	63	80
8	Weight on drivers, lb.	247,300	267,300	263,127	286,890	281,440	202,880	235,800	110,001	244,500	270,000
9	Total weight of engine, lb.	420,900	460,000	460,270	499,600	608,170	309,140	315,600	184,167	340,000	483,000
10	Tractive force, lb.	58,300	62,800	63,900	66,000	76,400	44,460	61,500	23,880	65,700	63,800
11	Boiler diameter, first course, inside, in.	82⅝	84¼	84½	88¼	91⅛	76⅝	76⅝	65⅛	88	86⅜
12	Boiler diameter, largest, outside, in.	94	96	98¼	102	102	89	89	73	92⅝	100
13	Length over tube sheets, ft.-in.	22-0	21-6	21-0	21-0	22-0	19-1	19-1	15-1	19-0	19-0
14	Combustion-chamber length, in.	60	80	72	64	113	36	36	....	33	90
15	Grate area, sq. ft.	97.7	90.4	97.8	108	132	69.3	70.0	55.5	66.3	100.2
16	Tube and flue heating surface, sq. ft.*	4,402	4,502	4,181	4,851	5,001	3,729	3,716	2,471	3,437	3,971
17	Firebox heating surface, sq. ft.*	379	385	568	552	660	304	299	157	363	499
18	Total evaporative heating surface, sq. ft.*	4,781	4,887	4,749	5,403	5,661	4,033	4,015	2,628	3,800	4,470
19	Superheater surface, steam side, sq. ft.	2,265	2,086	1,497	2,366	2,085	908	908	....	1,051	1,900
20	Firebox volume, cu. ft.	....	600	613	712	844	380	380	205	390	689
21	Gas area through boiler, sq. ft.	8.94	9.04	9.75	10.30	11.39	9.10	9.10	5.26	8.81	9.90
22	Type of superheater	E	E	A	E	A	A	A	....	A	E
23	Steam area through superheater, sq. in.	69.8	67.1	66.0	78.3	157.1	45.6	45.6	....	51.3	70.4
24	Maximum evaporation, calculated, lb. per hr.	63,640	65,650	74,155	79,675	85,930	52,150	51.750	35,570	52,620	70,380
25	Maximum evaporation, on test, lb. per hr.	....	....	....	....	....	65,400	59,085	30,721	61,680	....
26	Flues, number and diameter, in.	195-3½	198-3½	58-5½	220-3½	69-5½	40-5½	40-5½	....	45-5½	184-3¾
27	Tubes, number and diameter, in.	38-2¼	49-2¼	198-2¼	52-2¼	219-2¼	237-2¼	237-2¼	315-2	199-2¼	50-2¼
28	Superheater units, number and diameter, in.	99-1⅝	101-1⅝	58-1½	111-1⅝	138-1½	40-1½	40-1½	....	45-1½	93-1¼
29	Gas area per 1,000 lb. tractive force, sq. ft.	.154	.144	.152	.156	.149	.204	.148	.220	.134	.155
30	Gas area per sq. ft. of grate, sq. ft.	.091	.100	.099	.095	.086	.132	.131	.095	.133	.099
31	Gas area per sq. ft. of tube and flue heating surface, sq. ft.	.00203	.00201	.00233	.00212	.00228	00242	.00246	.00213	.00256	.0025
32	Grate per 1,000 lb. tractive force, sq. ft.	1.68	1.44	1.53	1.64	1.73	1.56	1.14	2.32	1.01	1.57
33	Grate per sq. ft. total evaporative heating surface, sq. ft.	.0205	.0185	.0206	.0199	.0233	.0172	.0175	.0211	.0175	.0224
34	Firebox volume per 1,000 lb. tractive force, cu. ft.	9.90	9.55	9.60	10.80	11.05	8.50	6.18	8.56	5.93	10.80
35	Firebox volume per sq. ft. of gas area, cu. ft.	....	66.4	59.7	69.1	73.0	41.8	41.8	39.0	44.2	69.7
36	Firebox volume per sq. ft. of grate, cu. ft.	....	6.64	5.90	6.60	6.40	5.50	5.44	3.70	5.88	6.89
37	Firebox volume per sq. ft. total evaporative heating surface, cu. ft.	....	123.0	129.0	131.8	149.0	94.4	94.5	78.0	103.0	154.0
38	Firebox heating surface per sq. ft. of grate, sq. ft.	....	4.26	5.82	5.12	5.00	4.39	4.27	2.83	5.47	4.99
39	Firebox heating surface per sq. ft. total evap. heating surface x 100 sq. ft.	7.93	7.87	12.00	10.20	11.67	7.53	7.45	5.97	9.55	11.19
40	Total evap. heating surface per 1,000 lb. tractive force, sq. ft.	82.0	77.9	74.3	81.9	74.0	90.7	67.0	110.0	57.7	70.2
41	Total evap. heating surface per sq. ft. of grate, sq. ft.	49.0	54.1	48.5	50.0	42.9	58.3	58.8	47.4	57.3	44.7
42	Superheat. surface per sq. ft. total evap. heat. surface, sq. ft.	.473	.427	.316	.438	.369	.226	.227	....	.277	.425
43	Gas area through flues, per cent	90.8	88.7	56.5	88.7	57.5	43.5	43.5	....	50.3	89.0
44	Weight on drivers per 1,000 lb. tractive force, lb.	4,240	4,250	4,120	4,350	3,680	4,560	3,830	4,590	3,720	4,230
45	Total weight of engine per 1,000 lb. tractive force, lb.	7,210	7,330	7,200	7,570	7,960	6,950	5,125	7,690	5,170	7,560

*Water side.

may be justified from the standpoint of smoke elimination alone.

Because of the very high draft required in a locomotive boiler, the proportions of the draft-making equipment in the smokebox have received much attention in recent years and a great many tests have been conducted to discover the most efficient front-end design. The best arrangements arrived at differ considerably in design. The important result, however, is that the efficiencies of the draft arrangements have been increased by handling greater quantities of gases with lower back pressure, and that it has been possible to increase the diameter of the stack to a considerable extent without causing the trailing of smoke, which is undesirable from the standpoint of signal observation.

Curves are given in Fig. 4, which show the equivalent evaporation plotted against back pressure. The curve, test *ZM*, shows the improvements gained by the use of an improved front end developed for the New York Central class J1B locomotives as compared with the standard front end.

Superheater

Of all the improvements made on the locomotive, since George Stephenson invented the first one, the superheater holds the first rank. Its great success has been due to the fact that it attacks the heat cycle at a point where the losses are the greatest, i. e., in the cylinders, by the elimination of cylinder condensation during admission and expansion and re-evaporation at exhaust.

Of the many tests made that have proved the beneficial effects of high superheat, those conducted by the Pennsylvania have been the most complete and conclusive. In his report[10] on the performance of the superheated passenger locomotive E6s, C. D. Young presented a most thorough analysis of the beneficial effects obtained by the use of superheated steam. The following summary is quoted therefrom:

"The application of the superheater to this locomotive increases its economy from a minimum of 23 per cent to a maximum of 46 per cent, the economy increasing with the increased power required of the locomotive.

"It was found that 30 per cent higher capacity was derived from the E6s locomotive when using superheated steam than with the same size and type of locomotive using saturated steam."

This result was obtained with a comparatively low superheat, of 200 to 225 deg. F., as compared with present-day practice. This showed an average increase in economy of 1.15 to 2 per cent for each 10 deg. F. increase in superheat. Experience and tests have shown that this rate of increase in economy holds good up to the limits of present acceptable practice of 350 to 400 deg. F. superheat. That every effort must be made to maintain highest superheat temperature is apparent.

This problem has become more and more difficult as the available heat for superheating has been reduced because of the high heat absorption in the large fireboxes of modern locomotives. To compensate for this, much larger superheaters have been found necessary and the introduction of the type-E superheater was a natural development. This type has been used on most modern locomotives which have been built during the last fifteen years in America.

Because of the great influence that the superheater design has upon the efficiency and capacity of both the cylinders and the boilers, considerably more space could

[10] Test Bulletin, No. 21, Nov. 4, 1912, pp. 82-89, 150-151.

Table VI—General Dimensions and Boiler Ratios of Articulated Locomotives

1 Type	2-6-6-2	2-6-6-4	2-6-6-4	4-6-6-4	4-6-6-4	4-6-6-4	2-8-8-2	2-8-8-2	2-8-8-4	4-8-8-2
2 Railroad	C. & O.	S. A. L.	N. & W.	U. P.	Nor. Pac.	D.&R.G.W.	Gt. Nor.	N. & W.	Nor. Pac.	Sou. Pac.
3 Road class	H4A	R2	A	3900	Z6	L105	R2	Y6	Z5	AC7
4 Date built	1927	1937	1937	1936	1936	1938	1929	1936	1930	1937
5 Boiler pressure, lb. per sq. in.	210	230	275	255	250	255	240	300	250	250
6 Cylinder diameter and stroke, in.	20X32	22X30	24X30	22X32	23X32	23X32	28X32	25X32 39X32	26X32	24X32
7 Driving wheels, diameter outside tires, in.	56½	69	70	69	69	70	63	57	63	63½
8 Weight on drivers, lb.	379,000	330,000	430,100	386,000	435,000	437,939	544,000	522,850	558,900	514,800
9 Total weight of engine, lb.	450,500	480,000	570,000	566,000	624,500	641,900	630,750	582,900	723,400	639,800
10 Tractive force, lb.	81,240	82,300	104,500	97,400	104,500	105,000	146,000	126,838	140,000	123,400
11 Boiler diameter, first course, inside, in.	87	82⅝	91	96⅝	96⅝	92¾	98	95⅝	103¼	91⅞
12 Boiler diameter, largest, outside, in.	93¾	96	105⅛	102	102	102	111⅛	104¼	110¼	106⅛
13 Length over tube sheets, ft.-in.	24-0	24-0	24-1	22-0	23-0	22-0	24-0	24-0⅝	22-0	22-0
14 Combustion-chamber length, in.	78	72	115½	86	89	109½	84½	36½	72½	68
15 Grate area, sq. ft.	72.2	96.3	122.0	108.2	152.3	136.5	126.0	106.2	182.0	139.0
16 Tube and flue heating surface, sq. ft.*	4,807	4,914	6,062	4,756	4,993	5,563	7,395	5,207	6,800	5,990
17 Firebox heating surface, sq. ft.*	368	515	588	625	839	778	481	430	866	478
18 Total evaporative heating surface, sq. ft.*	5,175	5,429	6,650	5,381	5,832	6,341	7,876	5,637	7,666	6,468
19 Superheater surface, steam side, sq. ft.	2,246	2,380	2,703	1,630	2,090	2,628	3,515	1,775	3,224	2,601
20 Firebox volume, cu. ft.	....	532	843	862	1,013	1,060	....	630	1,215	....
21 Gas area through boiler, sq. ft.	9.36	9.13	10.95	10.46	11.05	11.20	12.50	10.72	13.61	11.75
22 Type of superheater	E	E	E	A	A	E	E	A	E	E
23 Steam area through superheater, sq. in.	63.5	68.4	80.3	68.3	83.2	79.7	99.4	68.3	98.7	79.7
24 Maximum evaporation, calculated, lb. per hr.	64-450	74,000	88,610	81,550	95,000	98,180	94,060	71,660	115,070	84,400
25 Maximum evaporation, on test, lb. per hr.	....	....	....	....	....	....	....	....	....	....
26 Flues, number and diameter, in.	180-3½ 15-3½	200-3½	239-3½	60-5½	73-5½	238-3½	281-3½	60-5½	280-3½	240-3½
27 Tubes, number and diameter, in.	38-2¼	38-2¼	57-2¼	222-2¼	192-2¼	61-2¼	88-2¼	223-2¼	92-2¼	91-2¼
28 Superheater units, number and diameter, in.	90-1⅝	103-1⅝	121-1⅝	60-1½	73-1½	120-1⅝	141-1⅝	60-1½	140-1⅝	120-1⅝
29 Gas area per 1,000 lb. tractive force, sq. ft.	.115	.111	.105	.107	.106	.107	.086	.085	.097	.095
30 Gas area per sq. ft. of grate, sq. ft.	.130	.095	.090	.097	.073	.082	.099	.101	.075	.084
31 Gas area per sq. ft. of tube and flue heating surface, sq. ft.	.00195	.00186	.00181	.00220	.00222	.00201	.00169	.00206	.00200	.00196
32 Grate per 1,000 lb. tractive force, sq. ft.	.89	1.17	1.17	1.11	1.46	1.30	.86	.84	1.30	1.12
33 Grate per sq. ft. total evaporative heating surface, sq. ft.	.0140	.0178	.0184	.0201	.0262	.0216	.0160	.0119	.0238	.0215
34 Firebox volume per 1,000 lb. tractive force, cu. ft.	....	6.46	8.06	8.86	9.69	10.10	....	4.97	8.68	....
35 Firebox volume per sq. ft. of gas area, cu. ft.	....	58.3	77.0	82.5	91.6	94.6	....	58.7	89.3	....
36 Firebox volume per sq. ft. of grate, cu. ft.	....	5.53	6.90	7.96	6.64	7.76	....	5.92	6.67	....
37 Firebox volume per sq. ft. total evaporative heating surface, cu. ft.	....	98.0	127.0	161.0	173.5	167.2	....	112.0	158.3	....
38 Firebox heating surface per sq. ft. of grate, sq. ft.	5.10	5.35	4.82	5.77	5.51	5.70	3.82	4.05	4.76	3.44
39 Firebox heating surface per sq. ft. total evap. heating surface x 100 sq. ft.	7.10	9.48	8.84	11.62	14.40	12.30	6.11	7.63	11.30	7.38
40 Total evap. heating surface per 1,000 lb. tractive force, sq. ft.	63.6	66.0	63.6	55.4	55.8	60.3	54.0	44.4	54.8	52.5
41 Total evap. heating surface per sq. ft. of grate sq. ft.	71.6	56.4	54.5	49.7	38.2	46.5	62.5	52.9	42.2	46.6
42 Superheat. surface per sq. ft. total evap. heat. surface, sq. ft.	.435	.438	.407	.303	.359	.415	.446	.413	.420	.402
43 Gas area through flues, per cent	81.7	91.2	88.4	54.5	62.8	88.2	86.0	54.0	85.4	82.8
44 Weight on drivers per 1,000 lb. tractive force, lb.	4,660	4,010	4,125	3,970	4,160	4,170	3,720	4,125	3,985	4,164
45 Total weight of engine per 1,000 lb. tractive force, lb.	5,550	5,835	5,455	5,820	5,975	6,100	4,310	4,600	5,160	5,180

*Water side.

be devoted to the discussion of superheater design than is here available. A great deal of research work and testing have been done with many different types of superheater units to discover the unit which will give the maximum superheat with the lowest possible draft loss and steam pressure drop, which is at the same time practical and keeps weight, first cost, and maintenance at a minimum.

The improved type-E superheater is a very excellent arrangement as it gives a combination of maximum evaporating and superheating surfaces coupled with the greatest possible gas area through the boiler and steam area through the superheater. This assures high sustained superheat at low as well as high rating with minimum draft and pressure loss.

Feedwater Heating

A feature of great value in obtaining sustained capacity of the boiler, which may only be mentioned here, is the beneficial effect of feedwater heating. The increase in economy or power output of a locomotive ranges from 8 to 14 per cent through the recovery of the heat in the exhaust steam that otherwise would be wasted. The feedwater heater is now well recognized as necessary for economical locomotive operation.

Conclusion

In conclusion it may be said that the modern locomotive boiler is a very effective steam generator. Boilers[11] which can produce highly superheated steam at a rate of 1 lb. equivalent evaporation per hr. per 1.3 to 1.4 lb. of total boiler weight, compare very favorably with stationary boilers of about the same capacity which weigh about four times as much, or 6 lb. per lb. of steam produced, not including stack, breeching, brickwork, or draft fans. The weight of the locomotive boiler cited includes the boiler complete, superheater, smokebox, front end, stack, stoker, grate, and water.

While continued efforts must be made further to improve the boiler, clearly, it is the engine which deserves the most attention, as its thermal efficiency is so low that even a slight improvement is important. This may mean less simple mechanical parts than in the present reciprocating engine, but the mechanical-maintenance forces of the American railroads have proved to their great credit that very difficult mechanical problems, such as those connected with the maintenance of Diesel and electric locomotives, can be handled successfully.

This gives hope that apparatus and equipment proposed for the improvement of the steam locomotive will receive favorable consideration in the future, and that the hazards of added complications will not be considered as formidable as they once seemed.

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[11] Class M1A, Pennsylvania; Class J3, New York Central.

Pioneer Zephyr Wreck

Damage to stainless-steel train which collided with a standing steam locomotive at high speed confined largely to first unit — Little damage to the locomotive

ON October 2, 1939, there was a head-end collision between a Zephyr type motor passenger train and a locomotive and two freight cars on the Chicago, Burlington & Quincy at Napier, Mo. The report of the Bureau of Safety states that the accident caused the death of two employees and the injury of 25 passengers, five railway mail clerks, one employee off duty, one porter, three dining-car employees, and three train-service employees. It was caused, first, by the opening of a junction switch by a trainman without authority or instructions which resulted in diverting the passenger train, the "Pioneer Zephyr," to an occupied track, and, second, by the failure to control the speed of the passenger train properly when approaching a junction operating against the current of traffic within yard limits.

What Happened

The Pioneer Zephyr, train No. 21, consisted of four articulated streamline units propelled by a 600-hp. Diesel-electric power plant. At Forest City, 5.9 miles south of Napier, this train crossed over to the southward track at 4:20 p. m., 2 min. late, and approached the yard limit board at Napier at a speed of about 75 miles an hour. It entered the open junction switch leading to the Wymore division and, while moving at a speed estimated to have been about 45 or 50 miles an hour, collided with locomotive No. 4973 at 4:25 p. m. at a point 859 ft. beyond the switch. The report states that the locomotive and two cars, standing at the water crane and, according to the evidence, with the brakes applied, were moved back 128 ft. by the impact; the driving wheels were derailed to the west and the rear end of the tender was knocked off center; the front end of the locomotive was considerably damaged. The front truck of the first unit of No. 21 was derailed and stopped crosswise of the track 10 ft. from the pilot of locomotive No. 4973; the front end of the first unit rested on the front end of locomotive No. 4973. The front portion of this unit was demolished a distance of 28 ft.; the power plant and its base support were driven back into the mail compartment. The articulation end castings at the rear end of the first unit and at both ends of the second unit were driven inward 8 to 16 in. and the ends of these two units were bent and damaged.

The employees killed were the engineman of No. 21 and the roadmaster who was in the power compartment. The employees injured were the fireman, the conductor, and the brakeman of No. 21.

The Cause

Among the operating rules applying to the conditions involved in the wreck is Rule 98, a part of which reads: "A train authorized to move against the current of traffic must proceed through yard limits at restricted speed." Timetable instructions provide that "Operators when on duty will handle switches at terminals and for movements as follows: . . . Napier Junction switch and crossover . . ." According to the evidence, the flagman of No. 92, the freight train in the yard at Napier, without authority or knowledge of conditions on the road, assumed that the Zephyr train, No. 21, would arrive at Napier on the northbound track, which would not involve the junction switch, and, contrary to the rules, aligned the switch for the movement of his train to the southbound track a few minutes before the arrival of No. 21, running against the current of traffic on that track.

The evidence is conflicting as to the speed at which the collision occurred. Several of the train-service employees of the two trains estimated the speed to have been about 50 miles an hour. The fireman on the motor train, who jumped shortly after the train passed through the junction switch, estimated the speed at that time to have been 45 miles an hour.

Facts Concerning the Stainless-Steel Train

In summarizing the evidence concerning the character of the equipment of the passenger train, the report continues as follows.

The Pioneer Zephyr consisted of four articulated units designed to operate without being intermingled or associated with other cars. It consisted originally of three units which are now the first, second, and fourth units and which were completed in April, 1934; the unit which is now the third unit was added in 1939. The second unit was originally a passenger baggage car and was converted into a full baggage car. These units are built of stainless steel. This material was cold rolled to a minimum tensile strength of 150,000 lb. per sq. in. The total weight of the train empty is shown as 290,000 lb.

The builder's records indicate that this equipment was built according to the Post Office Department specifications for the construction of mail apartment self-propelled cars and trailer mail apartment cars operated in connection with self-propelled cars. In these specifications, which were approved January 2, 1929, it is stated that where the total weight of an empty train does not exceed 300,000 lb., the static end load is to be assumed as 100,000 lb. According to the builder, at the time these cars were built the Association of American Railroads had no specifications which were applicable; however, the specifications issued by the A. A. R. on March 24, 1939, for the construction of new passenger equipment provide for cars which may be used in trains of over 600,000 lb. lightweight, in which specifications it is stated that the Railway Mail Service specifications as revised July 20, 1938, were used as a basis. These specifications state that for a train weighing empty between the limits of 125,000 lb. and 300,000 lb. the assumed buffing static load is 100,000 lb.; this is identical to the 1929 specification. As the stress allowance in the new specification conforms substantially to those of the old specification, the cars conform not only to the 1929 specification, but also the more recent requirement.

According to the specifications of the Post Office Department, when the sills and framing members of rolled

steel have a minimum tensile strength of 50,000 lb. per sq. in., the stress shall not exceed 16,000 lb. per sq. in. This may be increased by 20 per cent for combined direct and secondary stresses and where other materials are used the stresses shall bear the same proportion to the ultimate strength of the material used. For stainless steel the maximum allowable stress is:

$$\frac{16{,}000 \times 1.20 \times 150{,}000}{50{,}000} = 57{,}600 \text{ lb. per sq. in.}$$

The records of the builder show that all stresses are well below this figure.

According to the builder, fabrication was by the Shotweld process, which is made in such a short time as not to affect the stainless properties of the steel and to eliminate appreciable annealing of the cold rolled metal. These units were designed to provide a factor of safety of five above the normal operating loads, as set up by the Railway Mail Service. In the Pioneer Zephyr the strength requirements were met without the use of the conventional center sill, using in lieu of this a floor system including the side sills. The floor system may be considered the center-sill construction of the later specification. The articulation castings were attached to two short sills extending approximately 10 ft. from each end and tied into the floor system. These sills were so attached to the floor system and other reinforcements that the required buffing load was transmitted to all the longitudinal strength members of the floor system. The coach-dinette, the third unit in the train, which was built at a later date, was equipped with a light center sill in addition to the normal longitudinal members, as this had become a standardized design.

Using the required 100,000 lb. buffing load, the builder's records show a maximum calculated stress of 37,530 lb. per sq. in.; as the maximum allowable stress under the 1929 specifications of the Railway Mail Service was 57,600 lb. per sq. in., the structure was so designed and built that it could have carried 50 per cent greater load without exceeding the allowable stresses.

The underframe and engine support of the power car were fabricated of Cromansil steel, arc welded and annealed. The material had a tensile strength of 90,000 lb. per sq. in. and a minimum yield strength of 55,000 lb. per sq. in., with an elongation of 25 per cent in 2 in.

Evaluation of Damage

The statement of the damage to the equipment, furnished by the carrier, showed a total of $54,000 to the first unit, of which $29,000 was to the car body and $25,000 to the power plant; to the second unit, $5,000, and to each of the third and fourth units, $500—a total of $60,000. The damage to the steam locomotive is placed at $400.

Aluminum Alloys Feature Missouri Pacific Trains

(*Continued from page 93*)

tion car. Fluorescent lighting in the dining section of the diner-bar-lounge car requires an additional 630 watts at 110 volts, single-phase a.c. In general, the lighting in these cars gives an intensity of about eight foot-candles at reading level.

A motor-alternator of 1,200-watts capacity, located under the dining car, is used to supply 110-volt current for fluorescent lighting, the radio and the cocktail mixer at the bar. A 300-watt motor-generator on each of the other passenger cars supplies 110-volt current for convenience outlets and the radio.

Safety steam-jet air-conditioning equipment with Vapor controls is applied on each passenger-carrying car, the refrigeration unit being of 7 tons' capacity and mounted under the car. One cooling unit is used per car, except on the diner-bar-lounge car, which has two 3½-ton cooling units, one for the dining section and the other for the bar-lounge section. Tempered air is distributed uniformly throughout the cars by multi-vent aluminum ceiling panels which are hinged for easy cleaning. The total electric load for the air-conditioning pumps, condenser fan and blower motors is about 119 amp, per car on the 32-volt circuit. Electric power requirements for exhaust fans, drinking-water cooler, range oil-burner motor and dish-washer motor reach a maximum of about 35 amps. on the 32-volt circuit in the diner-bar-lounge car.

Vapor heating equipment includes heat-tempering coils in the air-conditioning units and unit fin-type floor heat, all under thermostatic control, steam being supplied from a Vapor-Clarkson steam generator on the Diesel locomotive. Flexible steam conduits, and valves, steam couplers and wash-water heating specialties are also of the Vapor type.

Features of the Truck Design

Four-wheel trucks are used on all cars, with 6-in. by 11-in. journals on the mail-storage car, at the baggage end of mail-baggage car, and at the kitchen end of the diner-bar-lounge car. Other trucks have 5½-in. by 10-in. journals. The 36-in. rolled-steel wheels are carefully balanced before mounting on the A. S. F. roller-bearing unit housings which are equipped on these cars with SKF roller bearings. The wheel treads are ground after mounting, thus producing the good riding qualities resulting from concentric wheel treads and balanced rotating parts. National journal bearings installed in standard A. A. R. waste-packed jornal boxes serve as an added precaution against any car delay due to bearing failure.

The trucks are the single drop-equalizer, swing-motion type, with Commonwealth alloy-cast-steel frames having pedestals cast integral. Both equalizer and bolster springs are helical coil design of alloy steel. Vertical motion is controlled by Munroe shock absorbers and truck bolsters are restrained longitudinally of the car by the rubber-cushioned bolster anchor rods. Lateral sway is controlled on the diners and parlor-observation cars by a stabilizer arrangement, which replaces the conventional spring plank.

Sound-deadening materials, made largely of composition rubber, are used at bolster springs, truck center plates and body side bearings to isolate truck noises completely from the car body. Sound-deadening materials are also used at moving parts of the coupler and face-plate mechanism.

Westinghouse Schedule H.S.C. electro-pneumatic brake equipment with D-22-B control valves are applied on all cars. Speed-governor valves are applied on the baggage-mail cars and on the parlor-observation cars. Automatic emergency track sanding is provided at the inside pair of wheels on the rear truck of the first coach. There are two brake cylinders on each truck centrally located on each side, with Simplex clasp brake equipment having two standard brake shoes per wheel.

There is one Miner hand brake on each car, the vertical hand-wheel type being used at stub ends and the staff type of vestibule ends.

National tight-lock couplers are installed and draft gears are of the Waugh rubber type.

EDITORIALS

Give the Foreman A Chance

The foreman, whether on a railroad or in industry, holds a key position, but unfortunately, while the truth of this is recognized more or less generally, practice in many places does not indicate that it has got very far beyond the theoretical stage. The foreman makes the direct contact with the men in the ranks and to them he is the representative of management. A poor foreman can be a continual friction point as he deals carelessly and unintelligently with the men under his direction. On the other hand, he can be a tower of strength and influence if he deals with them wisely and tactfully.

Generally speaking, he has not had much special training or coaching in the art of dealing with men. This is the responsibility and fault of his superiors. In many instances, however, the foreman has taken the initiative and has given much time and expense to improving his knowledge of the principles of successful supervision. That more of them have not done this is probably due to the lack of understanding of their possibilities, or of how to get the right sort of knowledge and training.

It is a real inspiration to see what many of the local foremen's organizations have done, and the National Association of Foremen's Clubs has made a record of real accomplishment in stimulating its members throughout the nation to a larger appreciation of their responsibilities and the best ways to discharge them.

How are the foremen treated on the railways? In some instances with consideration and appreciation and real assistance in securing a knowledge of how to perform their duties. In other instances, however, the foreman is largely neglected and is regarded more or less as a cog in the wheel. A little round-up of several promising young men who entered the mechanical department in recent years has developed a very disturbing and pertinent fact. After critically studying the situation they have left the shop, in spite of the fact that they liked shop work, because of what they considered the unfair conditions under which a shop supervisor must work, i. e., imminent lay-off.

A railroad officer certainly dislikes, as well as any other man, the necessity of slashing forces when business slows up. In the long run, such a course is wasteful and inefficient. One railroad president has recently gone on record as to his determination to stabilize shop employment, in the knowledge that by so doing it will not only prove a paying proposition, but will be justified on a humanitarian basis. If it is important that this be done all the way down the line, certainly it is of prime importance when it comes to the foremen.

This, however, is not enough. The foremen should be given that attention and appreciation which will qualify them to act intelligently and enthusiastically for the management, and as sympathetic interpreters of the men and management to each other. Friction means waste and costs money. It can be reduced to a minimum by a recognition of the importance and value of the foreman in the organization and by giving him a reasonable amount of attention. It pays to keep cutting tools sharp and in good order. It is just as important to see that the foreman is constantly on the alert and is enthusiastic about his job.

Why Perpetuate Sloping Grates?

One of the details of design that has apparently outlived the conditions which justified its existence is the sloping of grates in the locomotive firebox. Several reasons have been cited as justification for the sloping of the grates downward from the back to the front of the firebox, among which are the necessity of elevating the rear end of the mud ring to allow sufficient clearance for the spring rigging when inside-journal trailer trucks were first introduced and as an aid to the fireman in stoking the front end of the firebox when hand firing was employed. Whatever the reasons are that made it desirable to slope the grates in the past, no satisfactory explanation has been given for the continuance of this design in new motive power.

In his paper before the Railway Fuel and Traveling Engineers' Association at the 1938 convention, F. P. Roesch, vice president of the Standard Stoker Company, called attention to the detrimental effect that the sloping of grates has on the fire bed, particularly in locomotives in high-speed service. The vibrations in these locomotives results in the fire bed creeping forward and building up a heavy fire at the forward end of the firebox and a thin fire at the rear. This condition prevents the admission of sufficient air in the front to support combustion and admits too much at the rear, thereby reducing the effective grate area by the amount covered by the heavy fire.

The beneficial effect that a larger furnace volume has in promoting complete combustion is discussed by C. A. Brandt in his paper on the locomotive boiler which he presented at the last annual meeting of the American Society of Mechanical Engineers. He pointed out that there is a loss of 18 in. in the depth of the firebox at the rear on many locomotives with

sloping grates, a condition that appreciably affects the furnace volume.

It has been proved that the seemingly unimportant details of design have a marked influence on locomotive efficiency. There seems to be no economic justification for the retention of sloping grates while there are very definite advantages to be had by the use of horizontal grates. There should be no hesitancy about discarding any feature of construction that adversely affects locomotive performance.

Fortunate Aspects Of the Zephyr Accident

On October 2, 1939, the first of the light-weight stainless-steel trains built for the Chicago, Burlington & Quincy by the Edward G. Budd Manufacturing Company collided head-on with a steam locomotive and two cars standing with brakes applied. An abstract of the report by the Bureau of Safety of its investigation of the accident appears on another page of this issue. As established by the Bureau's investigation, the accident occurred at a speed estimated variously from something less than 45 m.p.h. to 50 m.p.h. A remarkable feature of the wreck is the relatively small amount of damage done to the body units back of the leading unit which housed the power plant.

Two aspects of the performance of the equipment are of particular interest. One is the completeness of the destruction of approximately half of the first unit with relatively local damage to the rear end of that unit and the ends of the second and third units in the four-unit articulated train. The other is the fact that, with the exception of the front truck, the train stayed in line on the rails.

While the front end of the leading vehicle, in which was housed the Diesel-electric power plant, was badly crushed, the most complete damage occurred back of the power plant where the structure of the car was completely broken in two and separated. Back of this completely destroyed portion, however, the frame of the car was in sufficiently good condition so that it was restored to service by joining to it a newly constructed front section.

The character of the damage suggests that the Cromansil engine bed formed a structure so stiff that where it joined the more flexible stainless-steel floor structure of the car a stress concentration point developed, with complete crushing and destruction of all the longitudinal members of the car body, including sides and roof as well as floor structure. This destruction, localized at the middle and toward the front end of the leading unit, apparently absorbed a sufficient amount of the potential energy in the train so that, with the assistance of that imparted to the locomotive and cars which were moved down the track with the brakes set a distance reported to have been 128 ft., the remaining structures of the train were not subjected to completely destructive forces. There was sufficient local distortion at the rear end of the front unit, at both ends of the second unit, and at the front end of the third unit, however, to dissipate considerable additional energy and none of the passengers who were riding in the third and fourth units was seriously injured.

The fact that the articulation connections between the car bodies kept the train intact as a unit may have had much to do with the protection of the structures of the last three body units. Once the cars in a train separate under collision shocks, all control of the point at which, and direction from which, forces will be applied to the structures is lost, and the full resistance of the strongest part of the structure—that is, the underframe—is not brought into effective use.

It should be pointed out, however, that had there been no cushioning of the shock through the complete destruction of a part of the leading car and had the following cars been sufficiently strong to have remained intact, the probable effect on the passengers might very well have been disastrous. So far as they are concerned, it matters little whether they lose their lives by being thrown about violently within an undamaged car structure or by being crushed in a falling car structure.

In accidents of this kind the protection of the passengers would seem to depend as much on the cushioning effect of the destruction of some parts of the train as upon the resistance to destruction of other parts. The difficulty is to insure the probability that destruction will occur where the passengers are not involved, just as the failure of the front body unit protected the passengers in the accident to the Pioneer Zephyr.

Car Foremen Know Freight Car Details

In far too many instances, individual railroads issue specifications for new freight cars of various types without developing and utilizing as fully as might be desirable the suggestions of repair-track foremen, gang leaders and car supervisors in the lower ranks who know from direct personal contact how the detail parts of present equipment are functioning and which ones need to be improved in new designs. In other words, the chief officer of the car department and the mechanical engineer look at freight-car design from a more or less technical point of view to make sure that any new equipment which is ordered is designed to meet shipper requirements and have adequate strength to carry capacity loads safely. The car-department head also is responsible for the maintenance of this equipment and hence has a definite incentive to include such features of design and specialties as will assure reliable performance and minimum maintenance expense. "Two heads are better than one," however, and 50 heads are better still, so why not make an organized effort to

solicit the ideas of car supervisors all the way down the line when a new design of car is contemplated, for these are the men who really know both service and maintenance requirements to the last detail.

Consider, for example, the following suggestions regarding stock cars, presented by a car-department gang foreman at the February meeting of the Car Department Association of St. Louis. This man, who is intimately acquainted with stock cars from daily observation, says: "Stock-car side slats should be at least 1⅛ in. thick and spaced not over 3 in. apart. Side slats should always be bolted, and edge-grain lumber of a good grade, only, should be used in the space from one foot to seven feet above the floor. Stock-car interiors should be free from any projections, stock bars being located between the door posts. Side-door hasps should be of a collapsible type and side doors constructed so they will swing out at the bottom. Cars with metal roofs should be insulated. Pay more attention to keeping the roofs water-tight. Provide more cars adaptable for both single- and double-deck loading."

The reasons behind these suggestions are thoroughly understood by all well-informed car men. Most of the ideas are absolutely sound and are more or less standard practice on some roads. Probably the question of insulating metal roofs will require additional study, as stock-car sides offer little obstruction to the passage of hot summer air into the car interior, regardless of the type of roof installed. At the same time a load of hogs on the upper deck of a stock car having a metal roof unquestionably suffer severely from the heat when direct rays of the sun beat upon the roof. Presumably, tests should be made, if they never have been, to determine how much the temperature inside the car can be reduced by applying roof insulation.

Similarly, there may be some question about injury to stock from leaky roofs, considering that plenty of rain ordinarily comes in through the car side slats and, in hot weather, stock is frequently wet down with a hose to relieve over-heating. It is true that water leaking on stock in freezing weather would produce undesirable results, but in freezing weather, there would be no water to leak, so the force of this argument is somewhat dissipated. It may be stated as a reasonable conclusion, however, that the roofs of stock cars, as well as other freight cars, should be designed and maintained leakproof at all times.

The ideas quoted above are cited simply to show what one car foreman thinks about one particular type of freight car. Is it not possible that the composite views of a large number of car-department supervisors, from the highest to the lowest rank, covering all types of freight equipment, would be of inestimable value to the railroads, individually and as a whole? As far as joint action is concerned, it would apparently be well for local car foremen's associations to undertake a definite program of developing and co-ordinating the ideas of their individual members, and making this information generally available through their published proceedings. Ideas of general interest bearing on design could then be cleared through the national group of car supervisors, known as the Car Department Officers' Association and submitted for consideration by the Association of American Railroads, Mechanical Division.

New Books

ANNUAL PROCEEDINGS OF THE RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION. *Published by the association—T. Duff Smith, secretary, 1255 Old Colony Building, Chicago. Price, $2.*

In this volume are the proceedings of the third annual meeting of the consolidated International Railway Fuel and Traveling Engineers' Associations. Following the remarks of L. W. Baldwin, president of the Missouri Pacific, who addressed the coordinated meeting of the Railway Fuel and Traveling Engineers' Association, the Car Department Officers' Association, the Locomotive Maintenance Officers' Association, and the Master Boiler Makers' Association, are the reports and addresses pertaining directly to the work of the Railway Fuel and Traveling Engineers' Association. The subjects reported on were: "AB" Brake Maintenance and Handling; Proper Handling of High-Speed Passenger Trains with Graduated Release; New Locomotive Economy Devices; Avoidable Factors in Design Affecting Fuel and Locomotive Performance; Grates and Ashpans; Stationary Boiler Plants; The Turbine and Condensing Locomotive; Utilization of Locomotives; Locomotive Firing Practice, both Coal and Oil; Fuel Losses and Fuel Wastes; Fuel Records and Statistics.

DIESEL ENGINEERING HANDBOOK. *1939-40 de Luxe Edition. Published by Diesel Publications, Inc., 192 Lexington avenue, New York. Leatherette cover. Price, $6.*

This is a practical book addressed to the man who knows little about mathematics. It is couched in language as simple and non-technical as the subject will permit and will interest men having to do with the operation of Diesel engines who want to broaden their understanding of this type of prime mover. It will also be of value to the engineer whose experience has been in other directions. The book was first published three years ago. Since that time many important developments in the design of Diesel engines and their application have occurred, requiring its revision and rewriting. There are over 900 pages of text in thirty chapters. The book is profusely illustrated with photographs, drawings, and graphs. Not only does it deal with the design and operation of Diesel engines themselves, but there is also a chapter on vibration isolation, as well as chapters on the voltage regulation of Diesel-driven electric generators, flexible couplings, and clutches for Diesel drives.

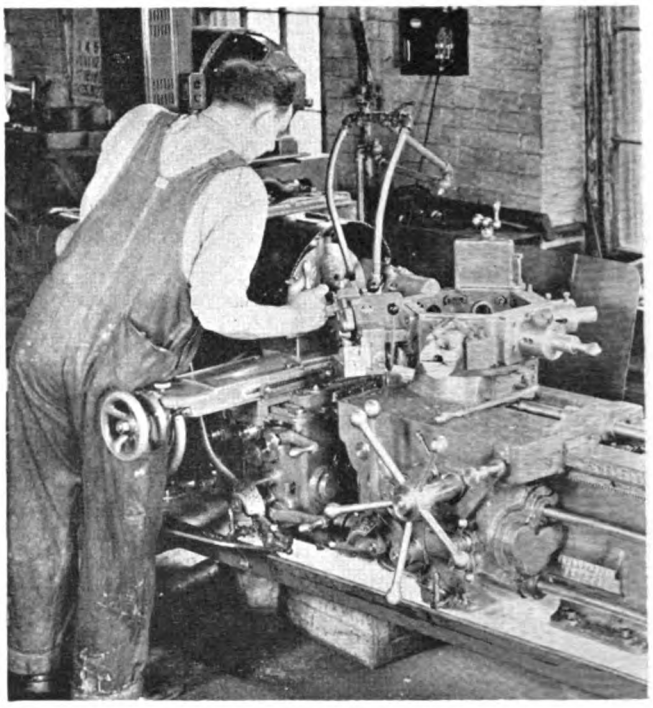
IN THE BACK SHOP AND ENGINEHOUSE

Turret Lathes In Tool Rooms

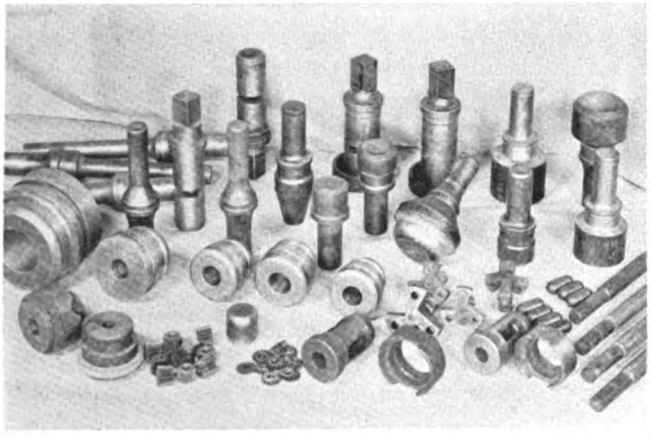
Precision and small-lot production, required in almost every large railroad tool room, make the job of holding shop operating costs to a minimum a difficult and perplexing problem. One railroad shop management met this problem by installing a modern high-production turret lathe in its tool room where an extensive variety of boilermaker tools and flue cleaners are made. These tools, illustrated in one of the views, include flue expanders, flue setters, rivet-buster pins, rivet snaps and sets, chisel blanks, flue rollers, expander pins and star flue cutters, parts which are made in small lots ranging from one or two per lot up to 12. The only exception is in the star flue cutters which are made in lots up to 1000.

The high-production turret lathe is fast enough to produce more work than two other types of lathes and, in addition, the parts are produced with a better finish and with greater accuracy. Turret lathes have not usually been considered to be tool-room equipment, but there are places such as this one where they can be used to advantage on account of their speed, accuracy and adaptability to the production of small lots.

Standard turret-lathe tools are designed for quick set-up and easy change-over from one job to another which materially reduces the time between jobs. Many of the tools have micrometer adjustment screws and dials which permit them to be quickly set for turning close dimensions. The machine has two single cutter turners which are used for accurately turning bars to correct diameters in the shortest time. The turners are rigidly constructed for taking heavy high-speed cuts and to maintain accurate dimensions. Another tool on this machine is the vertical slide tool used for facing, boring, back facing and recessing. It also has a micrometer adjustment which permits it to be quickly and accurately set for various operations. The quick-indexing square turret tool post holds four different cutting tools such as cut-off tool, right- or left-hand turning tools, chamfering tools, grooving tools, etc. A single to-and-fro movement of the lever unclamps, accurately indexes, and reclamps the square turret. Therefore, any one of these tools is quickly available without loss of time of setting up each individual tool.



Making boiler tools in small lots on a toolroom turret lathe



Boilermaker's tools machined on high-production turret lathe in railroad shop toolroom

Similarly, the hexagon turret holds six different tools any of which may be quickly brought into cutting position by indexing the turret. Many of the same tools are used from one job to the next and may require only resetting or substitution of a different size reamer, drill boring bar, etc., in the standard tool holders.

Modern high-production turret lathes also include many distinct operating features that speed up production and reduce the time required for machine operations. These include such features as power rapid longitudinal traverse to both carriages and also to the in-and-out movement of the cross slide, thus permitting the operator to bring the cutting tools quickly into position with a minimum of effort and loss of time. An automatic spindle brake quickly stops the spindle at the completion of a piece and holds the spindle while rechucking the next piece. Automatic feed stops or trips may be quickly set which facilitates duplicating dimensions when there are several pieces of the same kind to be made. Direct-reading speed and feed plates are provided which tell the operator at a glance the speed and feed he is using. Large micrometer dials, with observation clips are provided on the cross slide and on the cross-feeding hexagon turrets which facilitate quick set-ups or feeding to accurate dimensions. These are only a few of the operating conveniences that make turret lathes fast producers.

Many important features, which make these machines accurate producers throughout a long life, include solid hardened steel ways designed to eliminate practically all wear and preserve the original accuracy of the machine;

a spindle mounted on precision-type taper roller bearings; headstock gears made of high-carbon chrome-molybdenum steel, hardened and having tooth contours ground to give accurate rolling bearing and quiet operation, and an effective automatic built-in lubrication system which assures adequate lubrication to all important bearings and requires only a minimum of the operator's time.

Machine attachments that adapt these machines to practically any set of shop or tool room requirements include bar feeds and collet chucks for bar work, taper attachments for the cross slide or hexagon turret, thread chasing attachments for both the side carriage and hexagon turret carriage, power-operated or hand-operated compound rests for the side carriage, selective gear box and cross-feeding or fixed center hexagon turrets.

Guide Locating Device for Multiple-Bearing Crossheads

As part of a modernization program a southwestern railroad has equipped Mikado type locomotives with multiple-bearing guides and crossheads. In order to secure longer service, close attention is given to the manufacture and erection of the guides and crossheads. Parts are carefully machined to close tolerances, gages being used to check the grooves. Drilling jigs are provided to locate the holes in the guides to insure correct alinement when assembled. After the boring and turning operations, the crosshead is mounted on a special mandrel for machining the plane surfaces, insuring the correct relation of these wearing surfaces to the piston-rod fit.

The construction of multiple-bearing guides and crossheads permits erection as a unit and it has been found practical to locate the guide position accurately by alining the piston-rod fit of the crosshead concentrically with the center line of the cylinder. To facilitate this procedure a locating device, shown in Fig. 4, has been developed.

The guide and crosshead are assembled, placed in position and held by temporary bolts or clamps. The locating device is then placed in the crosshead as shown in Fig. 1. A line through the center of the cylinder and the bore of the device is put up in the usual manner. The crosshead is moved to a central position in the guide and adjusted laterally by testing with a thickness gage. It is locked in this position by the locking screws which are placed in the guide for locking the crosshead in an emergency. The guide is then permanently located by testing for alinement at both ends of the device. By using the centering head and scale as shown in Fig. 2, the entire assembly (crosshead and guide) can be moved until the scale touches the center line. The thickness of the usual center line, if it is of usual thickness, is negligible since the center head may be reversed so that the blade tested against opposite sides of the line, until equal pressure is noted on each side. The blade may then be adjusted in the center head allowing only enough to project so that it just touches the line at one corner of the scale. With the center head so adjusted and by placing it at various positions on the periphery, concentricity may be quickly determined, as shown in Fig. 3.

This device, although designed for use in connection with multiple-bearing guides, may be used to test the alinement of alligator, Laird and other types. Any discrepancy resulting from faulty workmanship, or other causes, is at once apparent.

Gas Cutter Has Wide Flexibility

The flexibility of use of the No. 10 Planograph announced by the Air Reduction Sales Company, New York, is demonstrated by its ability to gas-cut straight lines, rectangles, circles, and irregular shapes from ferrous metal of any shape within the present practical limits of the cutting torch. Although a stationary-type machine, the new unit can be readily moved by crane to different localities in the shop.

The carriage of the unit travels on a tracing table and supports the torches and the tracing devices. It operates on either 110 or 220 volts, a. c. or d. c. and, including the work table, requires a working area of only 5½ ft. by 10½ ft. The tracing device for manual tracing can be locked so that it will, without manual guiding, travel in a straight line in any desired direction. This time-saving feature is particularly convenient when cutting any irregular shapes which involve straight-line cutting. The devices for magnetic and template tracing can be quickly interchanged in the existing head. The magnetic tracer, connecting directly to an electrical outlet conveniently located near the top of the tracing-device head, requires 110-volt direct current for its operation.

Provision is made at the tracing-device head for connecting a lamp to light the work table. A switch for forward and reverse motion, and the magnet switch are also located at this point. The speed of the motor is

(*Continued on page 117*)

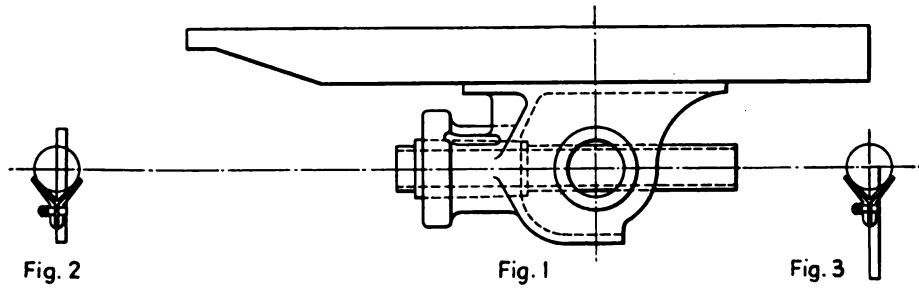


Fig. 2 Fig. 1 Fig. 3

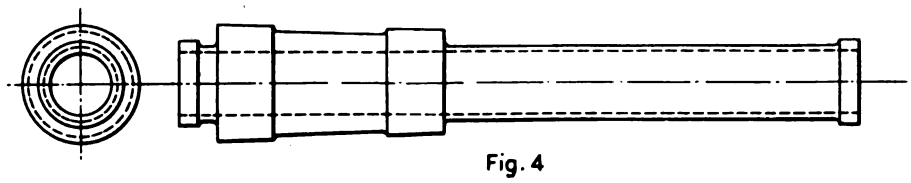
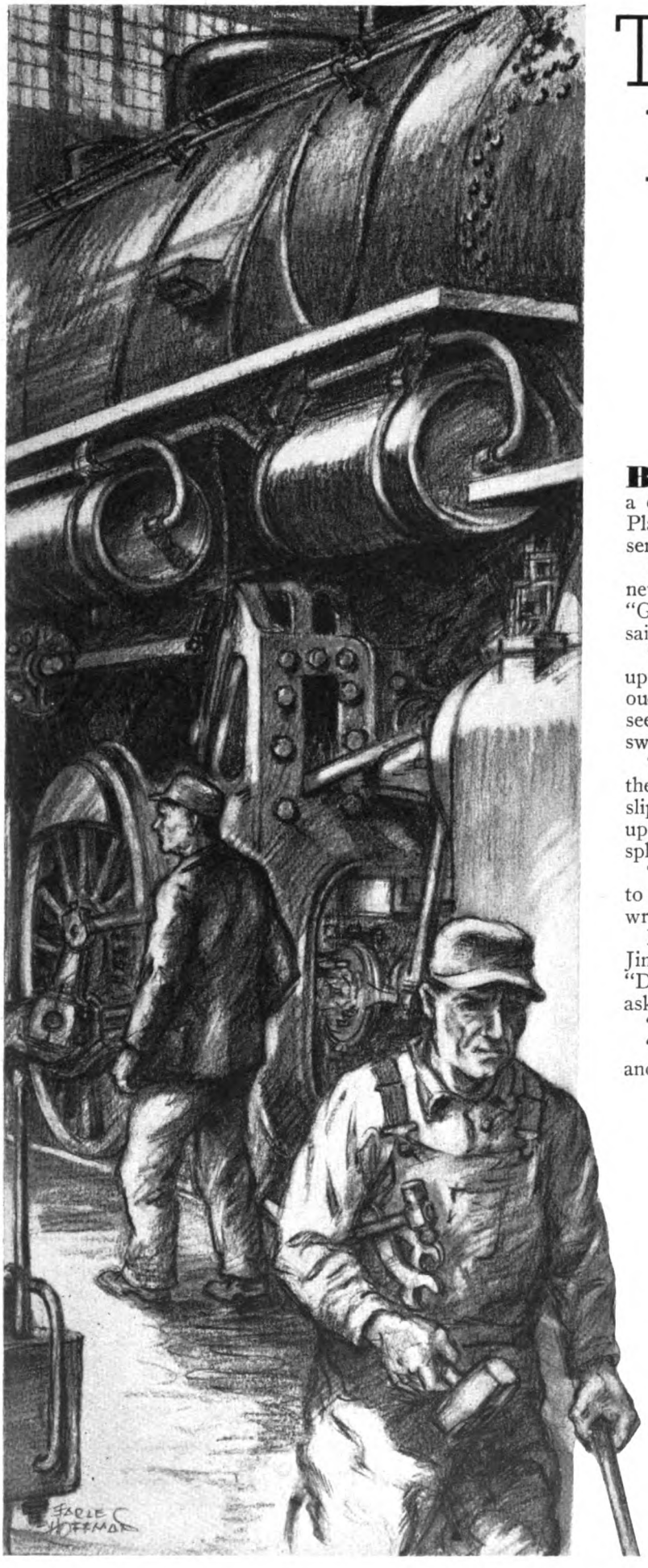


Fig. 4

These four figures show the method of using a device for locating guides with multiple-bearing crossheads



THE OTHER FELLOW'S JOB

by Walt Wyre

• • •

Bob Martin is a machinist. He works eight hours a day for the S. P. & W. in the roundhouse at Plainville. Being one of the oldest machinists in seniority, he works seven days a week.

Martin and his helper were just finishing renewing the left main rod bushing on the 5091. "Gosh, I'm glad that job is done," the machinist said. "It was sure one heck of a job!"

"Yeah," the helper agreed as he began to gather up tools. "They're a little mean when the pin is out of round and tapering besides, but I don't see what you're beefing about; I was the one that swung the sledge."

"Well, anyway, it's finished. You gather up the tools and put them in the box. I'm going to slip up in the cab and take a smoke. Come on up when you get the tools put away." The nut-splitter turned and started towards the cab.

"Wish I was a machinist," the helper growled to himself as he started off with an armful of wrenches, sledge, and a heavy buggy bar.

Martin didn't get to take his smoke just then. Jim Evans, the roundhouse foreman, came up. "Did you get through with the 5091?" Evans asked.

"Yeah," Martin replied, "just now finished."

"That's fine," the foreman said. "I've got another job for you. The tire on the right main driver of the 5086 is loose. I want you to reset it."

"O. K.," Martin said with just a trace of resentment. "I'll go tell my helper."

"I've already told him," Evans said.

Setting driver tires is not so bad when the wheels are out from under the engine, but it is something of a job when they are not.

While the helper was getting the tools, Martin went to the cab of the 5086 for a few quick drags on a cigarette.

"Wish I was a machinist," the helper growled to himself as he started off with an armful of wrenches, sledge and a heavy buggy bar

The tire wasn't very loose, but it showed signs that it had been working on the wheel. Both the engineman that came in on the locomotive and the inspector had reported the tire and the foreman had looked at it and decided not to take a chance on running it.

Natural gas used for heating tires in the roundhouse at Plainville has several advantages over kerosene. It is more convenient to handle and does the job in less time.

Evans, short on power as per usual, was anxious to get the 5086 as soon as possible. He paused several times when passing the engine to see how the machinist was coming along with the tire.

They did all right taking the tire off, but ran into a little trouble when they started resetting it. They heated the tire good and hot and it drove off easily. Martin measured the thickness of the shim and found it was 3/32 in. thick. He told his helper to go to the storeroom and get some 1/8 in. thick.

"That's going to make it pretty tight, ain't it?" the helper asked when he returned with the 1/8-in. shim stock.

"Not too tight, maybe," Martin said.

The wheel center was still fairly warm when they started on with the tire. Contact with the tire heated the wheel still more. Martin had a little trouble with the shim and the delay in driving the tire on gave the wheel and tire additional time for the temperatures to equalize.

"It's going pretty slow!" the helper panted as he swung the heavy twelve-pound sledge.

Martin, striking opposite the helper, dropped his sledge to see how the tire was going. If the machinist had not hesitated, the tire might have gone on without sticking, but it is doubtful. It lacked a full 3/4 in. being up and no amount of pounding would move it any further.

Evans, walking through the roundhouse, came by and stopped to see how they were getting along. He saw at a glance what had happened.

"Better let it cool off and try it again," the foreman said. "While you are waiting for it to cool you might key up the front ends of the main rods. I noticed they were reported." The foreman continued on his way through the roundhouse.

Martin stood watching the foreman walking slowly along. "Yeah, just like that!" The machinist snapped his fingers. "It's easy enough for him to say, but we are the ones that do the work. Wish I was a foreman—they sure have got a snap."

"They have to work twelve hours a day," the helper reminded.

"You mean they are on duty twelve hours a day. I could stand twelve hours doing nothing for the salary they get."

Evans, walking through the house, stopped at the 5077. The engine was overdue at the drop-pit and just begging for classified repairs, yet it was already marked up to run east on another trip. It was that or else. It was up to him to furnish power and the 5077 had to run. Evans shuddered slightly and walked away mentally resolving to tie the 5077 up next time in if it meant tying up the railroad.

Evans left the roundhouse and started to the office. The 5081 was just coming in and the foreman walked over to talk to the engineman. "How did she do?" he asked the hogger.

"She's a wonder!" the engineman replied. "Kept me wondering all the time whether it would fall apart or not."

"You made fairly good time," Evans reminded.

"It'll run," the engineman admitted, "but she sure needs a lot of work. It rides like a Model T on a corduroy road and you'd better do something to that feedwater pump. I could drink water fast as it pumps it into the boiler if I was very thirsty. The boiler needs washing, too," the engineman added as he picked up his tin suitcase and started to the washroom.

"The dispatcher wants to talk to you!" John Harris, the roundhouse clerk, came out of the office and hollered to Evans.

Dispatchers seldom have good news when they call the roundhouse office. They usually want an engine that is not ready or call to report a failure. This time it was a failure. The 5096 had knocked off a main pin while traveling fifty miles an hour. "Tore herself up pretty bad," dispatcher added and hung up.

The accident happened near Sanford and an engine was being sent from there to take the train in, so Evans didn't have that to worry about. The damaged engine would be sent to Plainville next day for repairs.

EVANS sat down at his desk and started to look over some mail that had come in. The first thing he picked up was a letter from the master mechanic reminding him in a very emphatic manner that too much overtime was being worked and that it would be a good idea to watch expenses and not run over the allowance as was done the previous month.

"How are we coming on our allowance " Evans asked the clerk.

"Just a minute." The clerk reached in a pigeon hole and pulled out a book. "Not so bad, about three hundred dollars over so far; today is the eighteenth," he added.

"Running nearly twenty dollars a day over," Evans thought aloud. "We've got to do better than that."

"Say, Mr. Evans," Ned Sparks, the electrician came in the office, "the overhead crane in the machine shop is all torn up."

"What happened?"

"Well, you know the 5092 was shoved up with the front end in the machine shop."

"Yes, they are changing the trailer wheels and had to push the engine into the machine shop to get the wheels over the drop-pit. What happened?"

"Somebody run the crane into the front end of the engine."

"How much damage did it do?"

"Haven't examined it yet," Sparks replied, "but it looks pretty bad, the crane, I mean; knocked the headlight off the engine and busted up some of the conduit and wiring."

Evans dropped the letter he was reading and started to the machine shop, the electrician coming with him. Two of the trolley wire supports on the crane bridge were broken off, as was the arm that supported the trolley wheels. One of the trolley wires was burned in half, the two ends dangling on the floor. The platform that carries the controllers was smashed to kindling wood and the light angle iron railing around the platform was bent in a semi-circle around the stack of the locomotive. Altogether it looked like a fair job of tearing things to pieces.

Evans swore, not long or loud, but fervently and with feeling. "How long will it take to get it going?" he asked the electrician.

"Can't say exactly," Sparks replied, "but I'd say at least five or six hours."

"It would happen right when I need the crane to handle a set of drivers that I'm in a hurry to get turned. Well, do the best you can and get it going soon as possible."

"Do you want me to work overtime? It's 3:15 now."

Evans had started to walk away. He stopped and stood a moment thinking of the letter he had just read. "Yes, work until you get it patched up so we can use it first thing in the morning." He started towards the roundhouse again and again the electrician stopped him.

"How about the platform? The carpenter will have to fix that. The hoist controller sets on the platform."

"All right, I'll tell the carpenter." Evans strode from the machine shop, stomping the cement floor at each step.

NEXT morning the 5096 and H. H. Carter, the master mechanic, both reached the roundhouse at about the same time. The official, red-eyed from loss of sleep, had come in on the Limited at 6:15 and didn't appear to be in a very good humor.

Evans was looking at the damaged engine when Carter came up. The dispatcher hadn't exaggerated any when he said it was pretty badly torn up. The main rod was knotted like a pretzel and parts of the valve rigging looked like gigantic corkscrews.

"Standing looking at it is not going to do any good," Carter said. "Why don't you get it in the house and get some men started to work on it?"

"The hostler will put it in the house soon as he gets around with the switch engine that just turned in," Evans said.

"Three failures in less than a week!" Carter continued. "What kind of railroading do you call that?"

"Not so good," Evans admitted.

"I'll say it's not so good. Pretty damned bad if you ask me! If we didn't have the failures I might be able to explain the overtime and running over your allowance, but say!—that pin was over half broke off—been that way no telling how long? Look at that!—where's the inspector?"

"The inspector couldn't have seen that crack with the rods up," Evans pointed out.

"Maybe not, but the rods have surely been off sometime and I'll bet that crack is at least two months old. We can't put up with that kind of railroading."

Evans couldn't think of anything to say that seemed appropriate and remained discreetly silent.

"How's your overtime and allowance coming?" the master mechanic changed the subject abruptly.

"Well, we are having a little overtime and are running some over on the allowance."

"Let's go to the office," Carter said, and started to the roundhouse office.

It's not often that Carter goes on a rampage, but when he does sulphuric acid drips from the corners of his mouth. He started on overtime, got going good on the allowance, worked himself almost into a frenzy about engine failures, and ended up with a vitriolic discourse on slipshod railroading in general as applied to the roundhouse at Plainville in particular.

Several times during the tirade Evans came very near flying off the handle himself, but his better judgment overcame the inclination and he managed to keep still, but at that the foreman didn't like it.

After Carter had left, Evans still stinging under the sharp tongue lashing went from the back room off the office where the monologue was delivered into the main office.

"The master mechanic is kinda on the war path, ain't he?" the clerk said.

"I'll say he is. He went from Genesis to Revelations and everything is wrong. It's easy enough for him to say what should be done, but doing it is something else. If I was a master mechanic and had nothing to do except find fault with foremen, I could find plenty too." Evans, realizing he had said more than he should, left the office.

CARTER, having relieved himself of surplus steam, went to his office feeling a little better but wishing that he had said less. After all Evans was doing as well as could be expected under the circumstances and conditions and a lot better than most foremen would. The allowance was short and no one could run a roundhouse without some overtime. As for engine failures, any man-made machine is bound to fail sometime.

Carter resolved to write a letter asking that the allowance be increased and that two more locomotives be assigned to Plainville—two more *good* locomotives and not ones that had been run on some other part of the railroad until they were ready to fall apart. He would write the letters just as soon as he had finished going through the accumulation of mail on his desk.

The first letter was from the superintendent of motive power and knocked any idea of asking for an increase of the allowance at Plainville. The letter said in no uncertain terms that the mechanical department was expected to stay within the allowance on all divisions, and that master mechanics would be held personally responsible for failure to do so on their respective divisions. The Plains Division was mentioned as one in particular that had in the past been a consistent offender.

Carter scratched his head and reached for another letter. It was from the same official and equally pertinent on the subject of engine failures. The gist of the letter was that unless there were fewer engine failures there would be some changes in master mechanics. In this case the Plains Division wasn't specifically mentioned, but if things kept going as they had been for the past ten days it would be.

Carter continued to read letter after letter until his tired eyes began to feel like his eyeballs had been smeared with grinding compound, the coarse kind.

Well, he would dictate answers to the ones requiring immediate attention, then go home and get a little rest.

Carter managed to keep his eyes open long enough to dictate the letters, but if they had been written exactly as spoken most of them would have read something like this: "To the superintendent of motive power—what did I do with that letter? Here it is—investigation of the failure of engine 5086—doggone I'm sleepy. What did I say, Miss Wilson? Tell them folks in the front office to pipe down; they're talking so loud I can't think. Failure of engine 5080—what was that engine number? —oh, yes, 5086 was caused by—that blamed telephone needs a muffler on it—now where was I——"

Thanks to a competent stenographer, the letters were written so as to make sense. The dictation finished, Carter yawned and relaxed to rest a moment before going home. His heavy eyelids took advantage of the opportunity and dropped over his eyes.

THE master mechanic slept nearly ten minutes. His chief clerk woke him up. "Just got a wire that the 5099 is coming in on the Limited in the morning. The superintendent of motive power wants you to meet it at Middleton and ride it over the division."

Carter woke with a jerk "What's that? Oh, yes, the 5099, it's the one they've rebuilt at the back shop—roller bearings throughout, automatic blowoff, all kind of new dingusses. Call my wife and tell her I won't be home for lunch or dinner either, for that matter. Find out what time 72 is called."

Number 72, a fast freight was called for 11:10. The master mechanic picked up his ever-ready handbag and left the office.

He went to the caboose track intending to put his hand-

bag in the way car, but the switch engine had already taken the caboose to the yard. Carter went to the beanery, lugging the handbag. A piece of pie and a cup of coffee was all he had time to eat. He made the caboose just as the car inspector waved his cap as a signal to the engineer that the train was ready to go as far as he was concerned.

The crew was ready too. A short toot-toot and the train pulled out at 11:14.

Carter looked at his watch and a sleepy smile flickered over his face. He stretched out on one of the long seats on a caboose cushion, one end of which he turned under to form a makeshift pillow. When the rear brakeman closed the main line switch, Carter was sound asleep dreaming of a railroad that ran no night trains, never had engine failures, and the master mechanics had Sundays off.

As long as the train was moving, the master mechanic slept. When it stopped an hour and twenty minutes out of Plainville, he woke up. "Where are we?" he asked the conductor.

"About two miles this side of Norton's Spur," the conductor replied as he opened the caboose door.

"What are we stopped for?"

"Don't know," the conductor answered as he left the caboose and started toward the locomotive.

Carter sat up and rubbed his eyes. He waited about two minutes hoping the engineer would signal the flagman to come in, but he didn't. He put on an overall jumper from the handbag and started to the front of the train.

The right trailer brass was hot, and it *was* hot. The oily waste burst into flames when the box was opened. They cooled the hot journal with water, repacked the box, and were ready to go, but only after losing nearly twenty minutes.

"Think it will run now?" the master mechanic asked.

"Don't know," the conductor replied, "but I doubt it. May have to rebrass it."

Carter sat on the brakeman's seat in the locomotive cab and dozed. The acrid odor of hot oily waste woke him up.

It took forty minutes to cool the journal and put in a new brass, all hands including the master mechanic helping.

Carter rode the locomotive to Sanford, the first division point. While the engine was being serviced, he dropped off at the eating house for a cup of coffee. He rode the caboose from Sanford to Middleton and slept two hours and thirty-six minutes of the two hours and forty minutes it took to make the run.

It still lacked two hours and ten minutes until time for the Limited. While he was waiting, the master mechanic walked over to the roundhouse to see how things were going. They weren't going so good. He found the lead machinist—there is no night foreman at Middleton—and one of the day machinists working on an air pump that had decided to take a pension. The day machinist was on overtime.

"What's the trouble?"

"Don't know," lead machinist replied. "The engineer reported it wasn't working good. We tore into it and can't find anything wrong. Haven't got another engine for the local," the machinist added.

"Shouldn't have any trouble finding what's the matter with it." Carter climbed up the short ladder for a look.

THE headlight of the 5099 was showing in the distance when they got the air pump going. Carter grabbed a piece of waste and rushed to the station wiping his hands as he went. By the time he had gone in the ticket office and out again with his handbag, the Limited was stopping at the station.

Carter intended to look the engine over while it was being worked, then go back to the Pullman and go to bed.

The superintendent of motive power climbed down from the cab of the engine. "Glad to see you," the s. m. p. said. "We've been having hell with that new type injector, and she's not steaming any too good. You ride the engine while I go back and catch a little sleep. Gonna get a bite to eat first."

Carter swore softly to himself, then said out loud: "Dammit, wish I was back helping machinists where I started—nothing to worry about and sleep every night!" He pitched his handbag up to the engine deck and climbed up after it. Five hours to go, nursing a new engine wheeling through the night at seventy miles an hour!

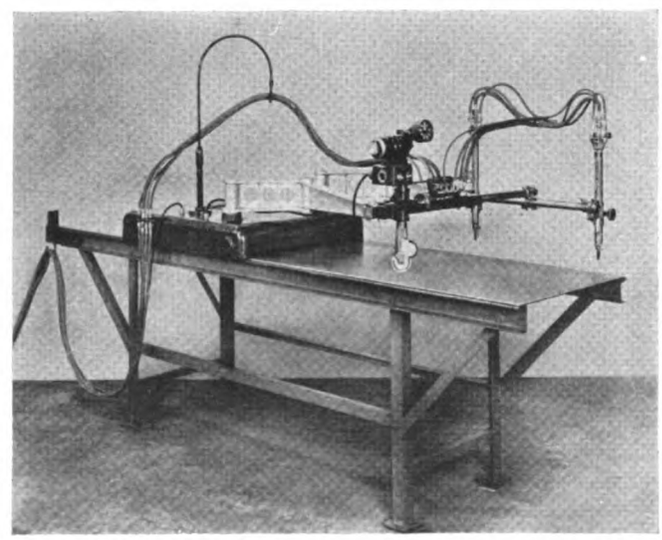
Gas Cutter Has Wide Flexibility

(*Continued from page 113*)

governed by a graduated disc known as the index speed control. One full turn of this disc controls the complete range of the motor speed. The cutting speed in inches per minute is registered on the reversible tachometer.

The gas-control unit on the No. 10 Planograph is centrally located. A knob handle operates cams, progressively arranged, one each for the pilot light, acetylene or other gas fuel, oxygen preheat, and cutting oxygen. One complete cycle lights and cuts off in proper sequence. Handwheels, mounted on either end of this unit, permit the lighting or extinguishing of the torch from either end of the tracing bar.

The cutting range in single-torch operation is 24 in. wide by 72 in. long and the length can be increased in multiples of 72 in. by utilizing additional tracing tables. The maximum diameter of circle cuts is 24 in. When two torches, mounted on the regular operating bar, are employed for simultaneous cutting, the cutting area for each torch is 12 by 72 in. Two circles up to 12 in. in diameter can be cut with the torches mounted in this manner. By using an auxiliary bar, the cutting area of each is 24 by 24 in.



The Airco No. 10 planograph gas cutter

With the Car Foremen and Inspectors

Missouri Pacific Rebuilds Seven Chair Cars

Typical of the passenger car reconstruction programs now being carried out on a number of railroads is the work of the Missouri Pacific in rebuilding seven old-style chair cars at the Sedalia, Mo., shops, as shown in the accompanying illustrations. The original 70-ft. chair cars were of all-steel construction, including the roof, steel and Agasote inside finish and deck, Hale & Kilburn double seats with a capacity for 68, 3-kw. belt-driven electric generators, conventional single-shoe brakes and some of the cars had ice-type air-conditioning equipment applied as early as 1935.

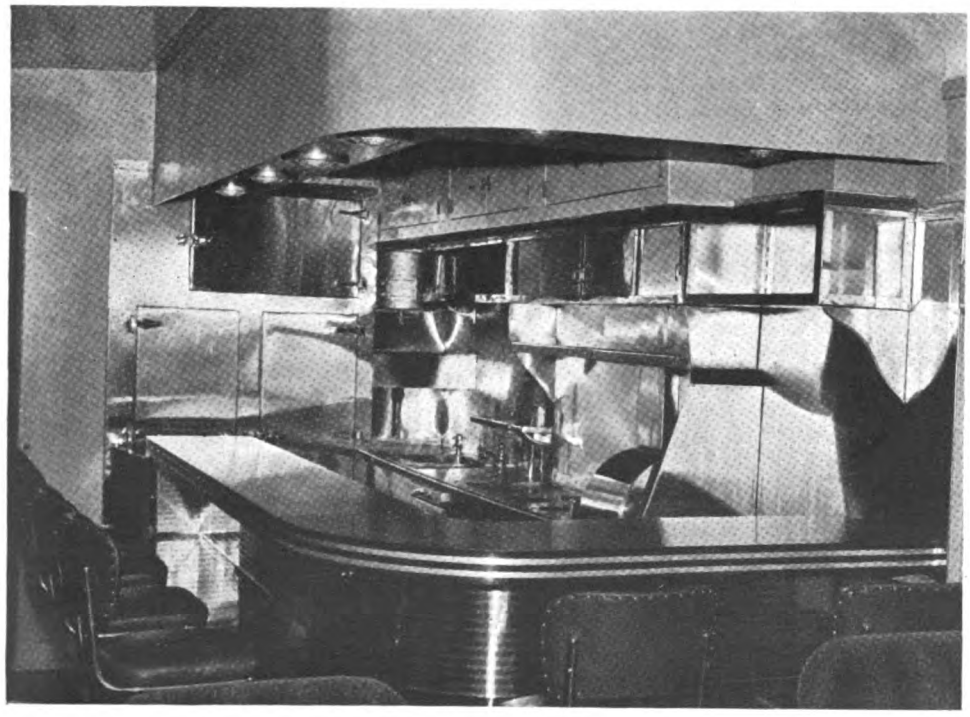
As reconstructed at Sedalia shops, three of these cars were made into deluxe divided coaches and given the new numbers, 6576, to 6578, inclusive. The interiors of these cars were completely redesigned and modernized throughout, two of them being equipped with 7-ton Frigidaire cooling units and one with a 7-ton Safety cooling unit. Double fresh-air intakes were installed in the roof at one end of each car, with an exhaust fan on the far side and the Burgess multi-vent system of air delivery in the main passenger compartments. The divided compartments are 36 ft. and 18½ ft. long and have seating capacities of 40 and 20, respectively, or a total of 60 per car. Modern-equipped men's and women's washrooms are installed at each end of the car. Double reclining back, rotating seats are supplied by the Transportation Seat Company. Continuous basket racks are installed and they support individual reading lights which are controlled from the respective seats. Improved center lights supply the general illumination.

From floor to window sills, the walls of the partitioned cars are finished in British tan at the base and lily-of-the-valley above. Bulkheads and partitions are finished in an artistic blending of these two colors. The ceiling is finished in bone white. The rubber-cushioned seats have walnut mohair upholstery.

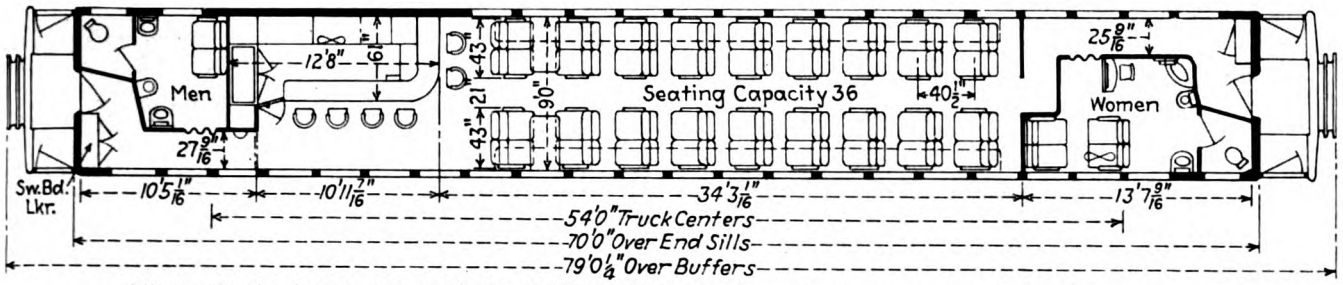
Vapor inner-tube floor heat is installed to supplement the overhead heating units, the amount of heating or cooling in the car being under thermostatic control. Electric power for air-conditioning, lighting, operation of the 9-in. railroad-type exhaust fans, etc., is supplied by two 3-kw. generators, with 25-cell A-10-HW batteries. The trucks for these reconditioned cars were transferred from other head-end equipment which had conventional six-wheel trucks with clasp brakes.

Similarly three others of the old chair cars, renumbered 6323 to 6325, incl., were converted into deluxe coaches, each having a single main passenger compartment, 41 ft. 7 in. long, and seating 44. This car has a 15-ft. men's lounge in one end, seating four, and an attractive 13-ft. women's lounge, seating four, in the other end. The total seating capacity of the car is therefore reduced to 52 to make additional lounge and wash room space available.

Air-conditioning and other equipment installed in these cars is the same as in the divided coaches. Double one-part side window are used, with Pantasote curtains, Safety basket racks, Transportation seats and Westinghouse Schedule UC-1812 air brakes. The lighting fixtures were furnished by Safety and the Com-



Attractive modern stainless steel grill and lunch counter in car in one of the deluxe coaches



Missouri Pacific de luxe grill coach, No. 6413, rebuilt to provide maximum passenger comfort and convenience

monwealth cast-steel trucks are equipped with Simplex clasp brakes and 5-in. by 9-in. journals with 36-in. steel wheels. The deck finish is JM Sanacoustic and five plate-glass mirrors are supplied. The ceilings are finished in ivory and side walls with coral stone and rust. The women's lounges are finished in honey yellow and wedgewood blue, while the men's lounges are done in British tan and lily-of-the-valley.

The seventh car, renumbered 6413, is a 70-ft. deluxe grill coach, equipped with a seven-ton Frigidaire cooling unit and Burgess multi-vent air-distributing system in the ceiling of the car. The car roof is thoroughly insulated and covered with wood and mule-hide canvas, the fresh-air intake being located at one end of the car and an exhaust fan at each end. The main passenger compartment of this car, slightly over 34 ft. long, has a seating capacity for 36; a 10½-ft. men's room seating two is located at one end of the car and a commodious and well-equipped 14-ft. women's room, seating four, in the other end. Between the men's room and the main compartment is an 11-ft. stainless-steel grill and lunch counter, seating six, which brings the total seating capacity in this car to 42, exclusive of the lunch-counter seats.

A feature of the car is the compact, up-to-date kitchen behind the counter, equipped with a sink, coffee urn, griddle, gas burner, steam table, ice-cream container, etc. Additional patrons of the lunch counter are served at removable tables, which are used in conjunction with eight standard chairs, four at a table. This car has the same general type of seats, lights, continuous basket racks and attractive color schemes as are employed in the other deluxe coaches.

Car Yard Walkways

One important feature of car repair yards which may be considered a simple operation but involves considerable expense if figured accurately on an annual basis, is the maintenance of suitable walkways and truck roads alongside the repair tracks and also between the various shop buildings, storehouse, offices, etc. The illustration shows an ingenious method of using the crop ends of carlines, cut at the local mill room and used to form a satisfactory plank floor or walkway between rails. These crop ends are small pieces of 2½-in. oak, 5 in. wide at one end and tapering to nothing at the other end. By nailing two pieces together, with the small end of one against the wide end of another, a plank 2½ in. thick by 5 in. wide by about 40 in. long is formed which can be readily fitted in the desired position between rails and spiked to the track ties. This type of walkway is solid, safe, relatively smooth and durable. When repairs are necessary, it is easy to remove and re-apply small sections at a time. The cost of installation is small, the walkway being made of scrap pieces of lumber which would otherwise have little value.



A solid, safe and durable walkway is made of the crop ends of 2½-in. oak carlines

Repairing Underframes Of Refrigerator Cars

The steel underframes of refrigerator cars are subject to severe corrosive action and deterioration, especially between the bolsters and the car ends due to the action of brine drippings. One large private car company pays particular attention to making necessary repairs to these underframes, even when the cars are shopped for only medium heavy repairs costing between $400 and $600.

Cars with obviously defective underframes, when received at this shop, are shifted to the repair tracks and old bolts cut loose which secure the car bodies to the underframes. Each car body is jacked up about 10 in., and the underframe pried loose, one end at the time, and allowed to drop back on the truck bolsters, with the car body supported on 8-in. by 8-in. wood timbers resting on suitable horses outside the track. The underframe, resting on its own trucks, is then pulled from underneath the car, as shown in the illustrations, thoroughly inspected to see what repairs will be needed and all new material ordered. Defective parts of the underframe are cut loose, as are also worn parts, consisting primarily of side and end sills, some draft arms, body bolsters, crossbearers, etc. In general, the rivet heads are melted off



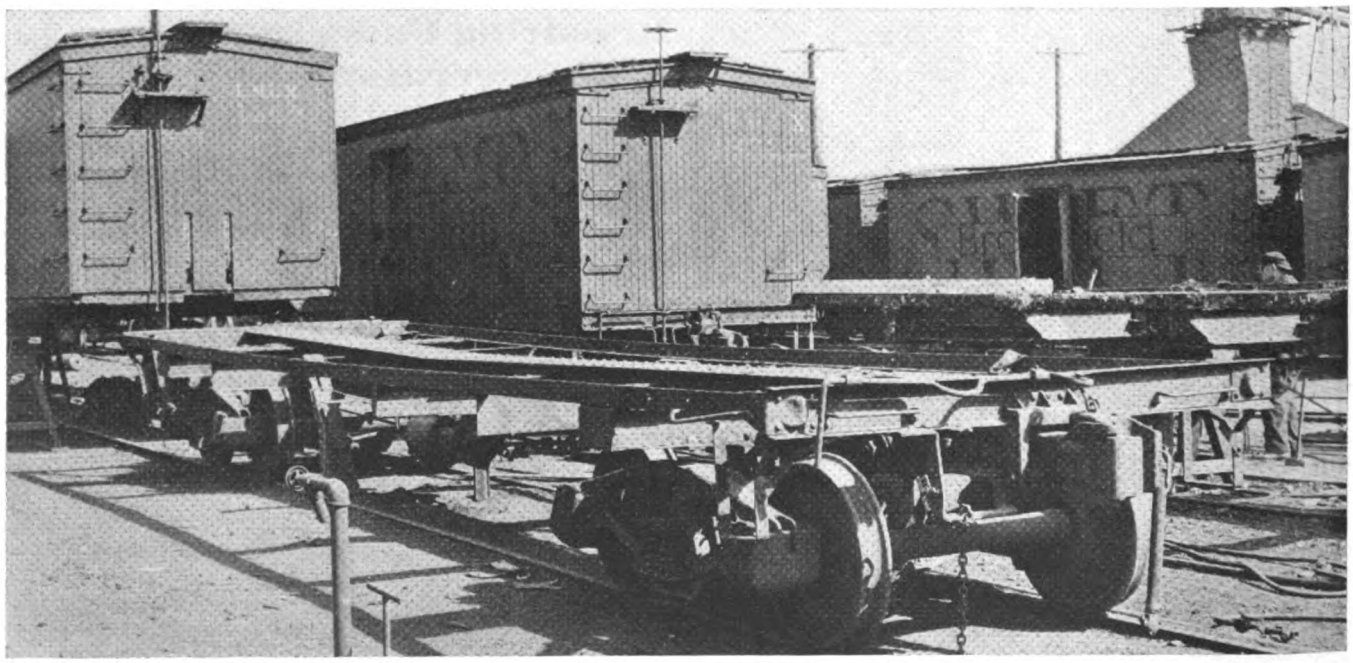
Loosening the scale and dirt from a refrigerator car underframe preparatory to applying a protective coat of car cement

with the gas cutting torch and the rivets backed out, thus permitting the defective parts to be removed.

The new materials and parts are received at the car by this time. They are fitted, the holes reamed and rivets driven by a three-man gang, consisting of one riveter, one bucker, and one extra steel man. This gang makes repairs both to the underframe and to the trucks; they are experienced in all phases of the work and are thus able to concentrate their efforts where most needed. For example, this arrangement enables two men to work together on the heaviest operations, leaving the extra man available to take care of whatever work can be done most efficiently by one man.

As soon as the underframe has been repaired, the next job is to clean it thoroughly of all rust, scale, dirt, etc. In the case of heavy repair cars, the underframe is usually cleaned by sandblasting, but for medium repair jobs costing less than $600, the underframe is cleaned by hand, using a shop laborer who operates an Ingersoll-Rand No. 16 air-scaling tool, as shown in one of the illustrations. This tool consists of a star-shape chisel, pneumatically operated at high speed in a short-head hammer with a long handle which greatly facilitates loosening scale and dirt in relatively inaccessible places. The rapid vibration of the chisel quickly removes the scale and dirt and gets down to the base metal which is thoroughly cleaned and ready for a coat of preservative paint. About one hour is ordinarily required for this operation.

The upper surfaces of the underframe which come in



Refrigerator-car underframe removed from the car body ready for thorough inspection and repair

contact with the car body are then painted and the underframe, supported on its repaired trucks, is pushed back under the car body which has been thoroughly overhauled and repaired in the meantime, defective sills being renewed and other necessary work attended to. The car body is lowered on the underframe in the reverse of the operation previously described and necessary holding bolts and tie rods applied through the side sills, end sills, transoms, draft sills, etc. The car body and underframe are then completely painted and the car is ready for another period of effective service.

Single-Board Refrigerator Car Roof

Water and cinder leakage often give trouble and are the source of damage claims in refrigerator cars, especially those equipped with double-board roofs in which moisture-proof paper is applied between the two layers of tongue-and-groove boards to make them watertight. The fact is that the board surfaces in contact with the paper are ventilated very poorly, if at all, and once they become wet do not thoroughly dry out again. Rotting and roof deterioration accordingly take place and leaks develop in a comparatively short period of time.

The single-board roof design, illustrated in the drawing, is by no means a new development, but competent car maintenance supervisors say that it may be positively relied upon to exclude water and cinders from the car interiors for service periods up to 10 years, providing desirable paint conditions are maintained by shopping the car every three or four years for necessary attention to this important detail. Regardless of the frequency of painting, the double-board roof, on the other hand, is said not to give a satisfactory service life of over four to five years.

The effectiveness of the single-board roof, in excluding water and cinders is due solely to two simple features of construction, namely, (1) the application of 45-lb., three-ply asphalt paper over the old car roofing and new sub-carlines in such a way that there is sufficient slack to prevent any possible tearing of the paper under normal weaving action of the car body; (2) the application of the new single-board outside roof in such a way, as shown in the drawing, that it is fully ventilated and dries out in a short time after being wet.

Referring to the drawing, it will be observed that one course of insulation paper is laid over the old roofing and then the new sub-carlines are applied. A single course of 45-lb., 3-ply asphalt paper is then laid in two strips lengthwise of the car roof, overlapping about 5 in. at the ridge pole, and fitting loosely over the sub-carlines in such a way that there is considerable slack. Experience has shown that if the asphalt paper is fitted accurately to the car roof and laid under the carlines, weaving of the car usually tears the paper and causes leaks, frequently on the first trip. This result is avoided when the asphalt paper is applied as shown in the drawing.

The new sub-purlines and new single-board tongue-and-groove roofing are applied, as indicated, the construction at the car side being such that a ⅜-in. air space is left between the outside fascia and the sub-fascia along the entire length of the car except where the plywood spacing blocks are located. This construction permits any water or cinders which leak through the outside roof to fall on the asphalt paper, work down the incline of the car roof and drop out through the openings at the car sides. By the same token air can pass readily in and out through these openings, thoroughly ventilating and drying the underside of the single-board roof. Freedom from rotting and long roof life, without leakage difficulties are thus assured.

Air Brake Questions and Answers

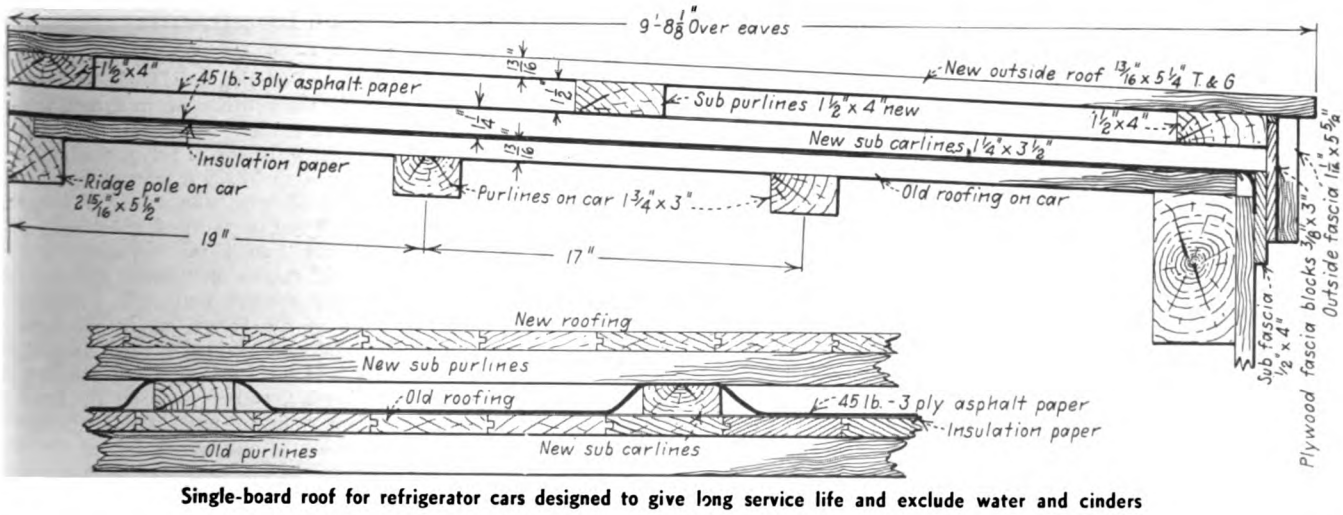
D-22-A Passenger Control Valve (Continued)

551—*Q.—What must be done when applying new shoes?* A.—Turn the ratchet nut to the left, thus moving the cylinder lever toward the brake cylinder until sufficient slack is introduced in the brake rigging.

552—*Q.—What must be done to bring the shoes closer to the wheels?* A.—To bring the shoes closer to the wheels and shorten the piston travel, the ratchet nut should be turned to the right.

553—*Q.—How should the piston travel be adjusted for truck-mounted cylinders?* A.—When the piston travel is less than 4 in. or more than 5 in., the slack adjuster should be adjusted so that the piston travel is 4½ in. with 50 lb. brake cylinder pressure.

554—*Q.—How is the screw adjustment proportioned?* A.—So that the brake shoe is compensated for at the rate of about 1/32 in. for each operation of the adjuster, thereby removing the danger of unduly taking up false travel which would result in the shoes binding on the wheels.



Single-board roof for refrigerator cars designed to give long service life and exclude water and cinders

High Spots in

Railway Affairs . . .

Railroads Foster "Drive-Yourself" Service

It is expected that by May 1, "drive-yourself" automobile service will be made available to railroad passengers in 150 cities in 30 western states, by 11 railroads. An independent organization, The Railway Extension, Inc., Chicago, will own and operate 2,000 automobiles at certain points; it has enlisted the co-operation of "drive-yourself" companies at other points. It will act as the clearing house for automobile reservations, which can be made through railroad ticket agents, such service to be provided at attractive rates.

A Good January

Railway operations for January showed a decided improvement over those for the same month last year; this was also reflected in railway employment. Preliminary reports from 87 Class I railroads, representing 82.6 per cent of the total operating revenues, showed an estimated increase in operating revenues of 12.4 per cent, as compared to January, 1939. Interstate Commerce Commission figures indicate that 988,870 workers were employed in January of this year, or 6.12 per cent more than in January, 1939. While employment in all groups was above that of last year, the greatest increases were an 11.31 per cent rise in maintenance of equipment and stores employees, and a 7.6 per cent increase in the train and engine service group.

Dolling Up Freight Trains

Successful merchandisers have in recent years given much attention to the attractive packaging of their wares. Designers of streamlined and high-speed passenger trains have found it advantageous to employ specialists to improve the artistic appearance of both the interiors and the exteriors of such trains. A rather spectacular improvement has been made in freight train operation, both in scheduling the trains and speeding up their movements, so that long distances are covered in overnight deliveries. Shippers are keenly appreciative of these improvements in service. To give it still greater emphasis, more and more attention is being given to the appearance of these fast merchandise trains. As an example, the St. Louis-San Francisco is replacing the conventional cars used on its Flashes with cars painted a light tan on the bodies and dark brown on the doors, ends and roofs, with vivid orange lettering and markings.

S. 2009 in Conference

It will be recalled that before the adjournment of the last session of Congress, both the House and Senate passed transportation bills which were numbered S. 2009. These differed quite materially in form, as well as in some of the policies. They were referred to conference and it seemed to be understood rather generally that the conferees would get together between sessions of Congress and have something to recommend as soon as the present session of Congress convened. The senators and representatives were busy back home, between sessions of Congress, cultivating their constituents and the conferees only got down to brass tacks in considering S. 2009 last month. Reports are not given out as to the progress which is being made, but enough information has leaked out so that it is pretty well understood that there are marked differences of opinion on some of the more important phases of the proposed legislation. Since the conferees are seasoned legislators, they will undoubtedly find some way of compromising, and there is at least a reasonable possibility of the bill reaching the House and Senate. Just when this may occur, if it does, is hard to predict.

Wage Payments Dependent on Earnings

The Railway Age in an editorial, entitled, "Wages Are Determined by Railroad Earnings, Not By Union Policies," in its issue of February 17, 1940, states that "total wage payments to employees bear, practically speaking, an unwavering percentage relationship to operating revenues." Statistics are presented covering the years 1903 to 1939, inclusive. "In the whole 17-year period," says the Railway Age, "wages never exceeded 50 per cent of operating revenues and never fell below 45 per cent thereof. They actually tended to remain at about 48 per cent of operating revenues, but in the periods of rapidly falling business the percentage was exceeded slightly, to be explained undoubtedly by the inability of managements to effect retrenchments as rapidly as revenues declined. Similarly, in years of rapid improvement in business, re-employment tended to lag behind the improvements in business and gave, temporarily, a slightly lower percentage of wage payments to operating expenses." In another place in the article the statement is made that "all that traditional union wage-raising activity has accomplished has been to reduce the number of employees among whom an independently-determined share of operating income is divided."

New Leader for Railway Labor Executives Assn.

George M. Harrison, young and vigorous railroad labor leader, who has been very much in the forefront during the past six years as chairman of the Railway Labor Executives Association, has resigned because the Brotherhood of Railway and Steamship Clerks, Freight Handlers, Express and Station Employees, of which he is president, "has been experiencing an amazing growth, needed more of his time." He was succeeded by James A. Phillips, a veteran railroad labor leader, president of the Order of Railway Conductors, who has acted as vice-chairman of the Railway Labor Executives Association for a long time.

Eastern Roads Will Go Back to Two-Cent Fare

When it comes to passenger business, the Baltimore & Ohio certainly keeps things stirred up in the eastern territory. It opposed the other eastern railroads in an application for authority to continue the 2½-cent coach rate, which was inaugurated in August, 1938. Because of the World's Fair fares, which were in effect during a great part of last year and which distorted the picture, the railroads contended that more time should be given to experimenting with the 2½-cent fare. In this they were over-ruled by the Interstate Commerce Commission, which in a seven-to-three decision concluded that "The future net revenue results to the eastern railroads will probably be more favorable under a two-cent, than under a 2½-cent basic coach fare." The lower rate will become effective on March 24.

Confidence in Railroad Investments

A forum sponsored by the Savings Bank Journal in Washington, D. C., in January, discussed the attitude of investors toward railroad securities. It lasted for six hours, from 5:00 p. m. to 11:00 p. m., and was participated in by 23 men acquainted with various aspects of the railroad industry. J. E. Oldham, a railroad consultant, suggested that "confidence in railroad investments will return only when investors are reasonably assured that it is going to be possible in the future, as in the past, to determine and maintain rates largely on the basis of service at cost, with all that the term implies, rather than on the basis of expediency made necessary by intensive competition of the newer forms of transportation, which have so generally prevailed since the depression."

(Turn to next left-hand page)





Supply the facts which prove that Chilled Wheels cost less. . . . . and the unique exchange plan, whereby a worn-out wheel is worth its weight in new metal, is only the beginning of Chilled Wheel economy. Because Chilled Wheels make possible these **3 additional savings,**

1. **Longer rail life**
2. **Longer brake shoe service and**
3. **Lower machine shop costs.**

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Among the Clubs and Associations

MECHANICAL DIVISION, A. A. R.—The Mechanical Division of the Association of American Railroads will meet at the Stevens hotel, Chicago, on June 27 and 28.

NORTHWEST CAR MEN'S ASSOCIATION.—Meeting March 4. Paper: Truck Spring Snubbers. Author: W. S. Spieth, manager, Simplex Snubber Department, American Steel Foundries.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.—Meeting March 19, 8 p. m., Hotel DeSoto, St. Louis, Mo. Speaker: C. F. Larson, superintendent of safety, Missouri Pacific. Topic: Safety Movement Evaluated.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—Meeting March 21, 10 a. m., Ansley Hotel Roof Garden, Atlanta, Ga. "Making and Shaping of Steel"—motion picture of Tennessee Coal, Iron & Railroad Company.

CANADIAN RAILWAY CLUB.—Meeting March 11, 8:15 Rose Room, Windsor Hotel, Montreal, Que. Speaker: Lewis C. Ord, general manager, Canadian Associated Aircraft, Ltd. Subject: Development of Air Power and Some of the Resultant Production Problems.

RAILWAY CLUB OF PITTSBURGH.—Meeting February 22. Speaker: O. W. Carrick, assistant vice-president, Electro-Chemical Engineering Corporation. Motion pictures showing behavior of steam and water in a locomotive boiler while in service.

NEW ENGLAND RAILROAD CLUB.—Regular meeting postponed to March 19, 6:30 p. m., Hotel Touraine, Boston, Mass. Reports; election of officers. Address by Dr. Phillip Thomas, research engineer, Westinghouse Electric & Manufacturing Company, with experimental apparatus and gadgets.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—C. E. Davies, 29 West Thirty-ninth street, New York.

RAILROAD DIVISION.—C. L. Combes, Railway Age, 30 Church street, New York City.

MACHINE SHOP PRACTICE DIVISION.—Warner Seely, Warner & Swasey Co., 5701 Carnegie avenue, Cleveland, Ohio.

MATERIALS HANDLING DIVISION.—F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

OIL AND GAS POWER DIVISION.—W. J. Hargest, American Machinist, 330 West Forty-second street, New York.

FUELS DIVISION.—A. R. Mumford, Consolidated Edison Co., 4 Irving Place, New York.

ASSOCIATION OF AMERICAN RAILROADS.—Charles H. Buford, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

OPERATING SECTION.—J. C. Caviston, 30 Vesey street, New York.

MECHANICAL DIVISION.—V. R. Hawthorne, 59 East Van Buren street, Chicago. Meeting Stevens Hotel, Chicago, June 27 and 28.

PURCHASES AND STORES DIVISION.—W. J. Farrell, 30 Vesey street, New York.

MOTOR TRANSPORT DIVISION.—George M. Campbell, Transportation Building, Washington, D. C.

CANADIAN RAILWAY CLUB.—C. R. Crook, 4468 Oxford avenue, N. D. G., Montreal, Que. Regular meetings, second Monday of each month, except June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT ASSCCIATION OF ST. LOUIS.—J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, DeSoto Hotel, St. Louis, Mo.

CAR DEPARTMENT OFFICERS' ASSOCIATION.—Frank Kartheiser, chief clerk, Mechanical Dept., C. B. & Q., Chicago. Annual meeting October 21-24, Hotel Sherman, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month.

CENTRAL RAILWAY CLUB OF BUFFALO.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday of each month, except June, July and August, at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION.—Roy MacLeod, Room 127, General Office Bldg., N. Y., N. H. & H., New Haven, Conn. Regular meetings, second Friday of January, February, March, April and October at Engineering Societies Bldg., 29 West Thirty-ninth street, New York.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—See Locomotive Maintenance Officers' Association.

LOCOMOTIVE MAINTENANCE OFFICERS' ASSOCIATION.—J. E. Goodwin, general foreman, locomotive department Missouri Pacific, North Little Rock, Ark.

MASTER BOILER MAKERS' ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y. Annual meeting October 21-24, Hotel Sherman, Chicago.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Thursday in each month, except June, July, August, September and December at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, 1931 University avenue, St. Paul.

PACIFIC RAILWAY CLUB.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Monthly meetings alternately in northern and southern California.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION.—T. Duff Smith, 1255 Old Colony building, Chicago. Annual meeting, October 21-24, Hotel Sherman, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

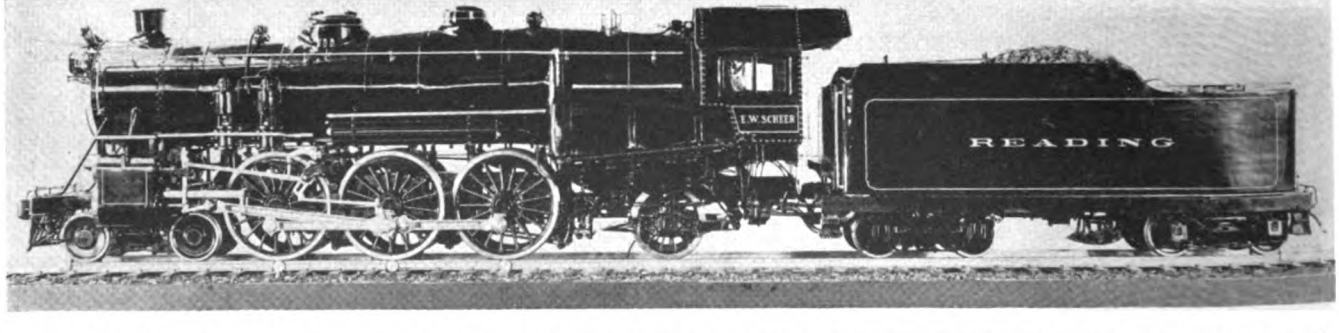
TORONTO RAILWAY CLUB.—D. M. George, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto, Ont.

TRAVELING ENGINEERS' ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

VALLEY ANTHRACITE CAR FOREMEN'S ASSOCIATION.—P. P. Kohl, executive secretary, 254 Barney street, Wilkes-Barre, Pa. Regular meetings third Monday of each month.

WESTERN RAILWAY CLUB.—W. L. Fox, executive secretary, Room 822, 310 South Michigan avenue, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

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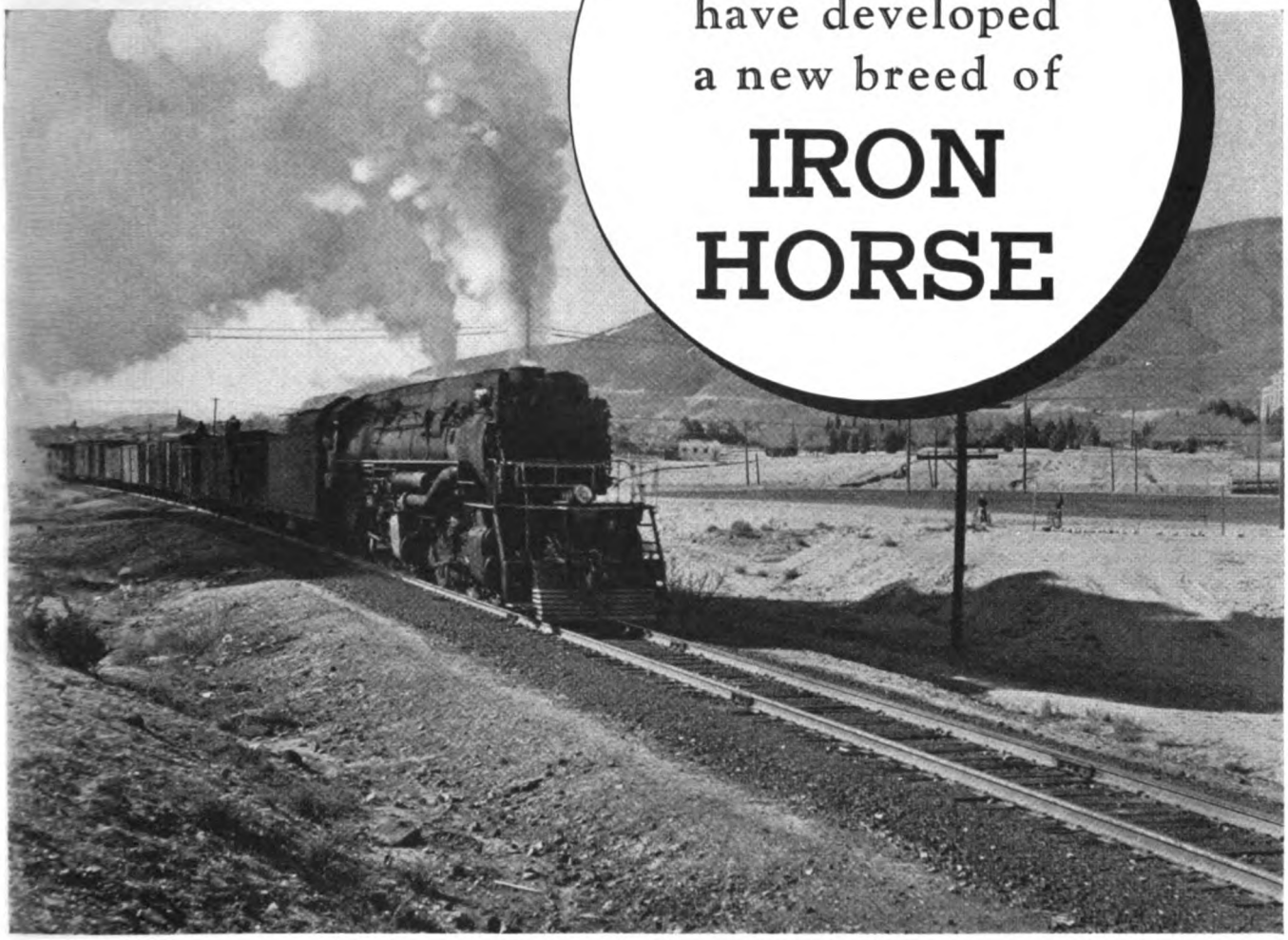
Reading shop apprentices recently completed this one-eight scale working model of a Class GIsa "Pacific" locomotive. The job was done in their spare time

(Turn to next left-hand page)

Changing Conditions

have developed
a new breed of

IRON HORSE



Today's increasing passenger and freight traffic demands have brought about the development of a new type of steam power . . . The Super-Power Steam Locomotive.

Lima has pioneered in locomotives of this type. From the experimental A-1 high-speed freight locomotive of 1925 up to the new improved 2-8-8-4 Mallets, that have recently been delivered by Lima to the Southern Pacific, Lima-built Locomotives have proved the money-making abilities of new, super-power steam locomotives.

LIMA LOCOMOTIVE WORKS LIMA LOCOMOTIVE WORKS INCORPORATED **INCORPORATED, LIMA, OHIO**

NEWS

K. C. S. Buildings Destroyed by Fire

THE general office building, storehouse, freight-car shops, mill room and wheel shop of the Kansas City Southern at Pittsburg, Kan., were completely destroyed by fire on January 18.

Four Hours Added to C. N. R. Shop Work Week

THE Canadian National has announced that its locomotive repair shops will be placed on a 44-hour week, in place of the present 40-hour week, effective immediately. The step has been taken because of a "distinct upturn in business that has taken place and is continuing."

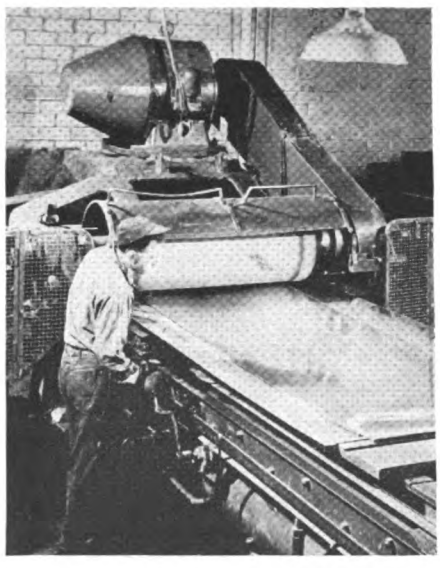
Enlarged Stainless Steel Plant at Massillon, Ohio

ON February 27, the Republic Steel Corporation formally placed in operation improved and greatly expanded stainless steel facilities at Canton and Massillon, Ohio, to meet not only industrial demands, but railway needs for all grades of stainless steel used in car construction. The stainless-steel finishing department at Massillon now occupies all wings of a five-acre building. The plant was previewed on February 27 by a large group of newspaper and trade paper editors, who also inspected a 25-ton electric furnace transferred from Buffalo and a completely new 50-ton unit which was recently added to the company's battery of six electric furnaces at Canton, where the stainless steel is produced.

With the exception of the hot rolling of coils which is done at nearby Warren, Ohio, Republic has now concentrated all its stainless steel operations in the company's plants at Canton and Massillon. The improved and expanded facilities give Republic a stainless capacity in the strip department alone of 1,200 tons per month.

With the new facilities, Republic will be able to produce coils of cold-rolled stainless strip as narrow as ¼ in. and as wide as 23 15/16 in. Polishing, which used to be done by the inch, is now done by the foot, the Massillon plant being equipped to polish a sheet 68 in. wide by 24 ft. long.

All Republic's stainless, which is sold under the trade name Enduro, is produced at the east-end plant in Canton. Except for the hot rolling of coils, all the finishing and processing is now done in the Canton and Massillon plants. Unpolished sheets and light plate are finished at Canton and polished sheets and plates and cold rolled strip are finished at Massillon. Part of the 5-acre building at Massillon had to be rebuilt to accommodate new equipment. Included there are three annealing and pickling lines which were moved from Republic's plant at Warren, and three new 4-high reversing mills, the largest a 34-inch unit, and a new 2-high skinpass mill.

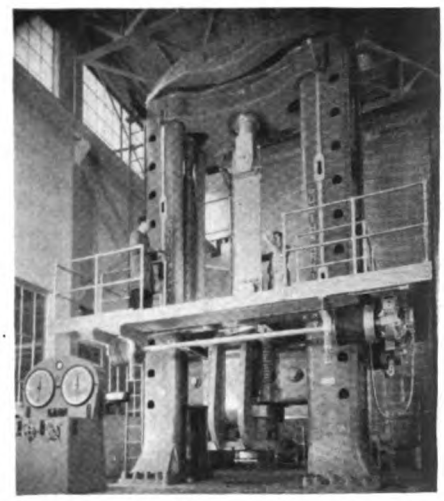


One of 15 polishing machines in the Republic stainless-steel finishing plant at Massillon, Ohio

A 3,000,000-Lb. Testing Machine Installed in Aluminum Laboratory

A HIGH-capacity, precision-testing and metal-working machine was demonstrated before a group of testing engineers, government officials, railway officers, and industrialists at the Research Laboratories of the Aluminum Company of America, New Kensington, Pa., on March 2. The new machine, called the Templin precision metal-working machine after R. L. Templin, chief engineer of tests, the Aluminum Company of America, was built by the Baldwin-Southwark Corporation and is capable of exerting a force of one million pounds in tension and of three million pounds in compression. While not the largest testing machine in existence, it is the most powerful. In compression, it can exert its full force up to a speed of 36 in. a min., which requires a 300-hp. motor-pumping 270 gallons of oil per min. against a pressure of 1,800 lb. per sq. in. For testing large structural specimens a pump driven by a 20-hp. motor delivers oil against the same maximum pressure at the rate of 18 gallons per minute.

Prior to the installation of the new machine the largest materials testing machine in operation in the company's laboratories was a 300,000-lb. tension and compression machine. A new program of research for the improvement of fabricated products as well as for the development of new ones, requires experimental work using suitable full-size equipment operating under precisely controlled conditions which can be obtained only in the laboratory. The new machine can be operated as an extrusion forging or forming press. Auxiliary equipment permits defining within close limits the relationships existing between the various forces in the plastic flow of aluminum through a wide range of conditions.



The Templin precision metal-working machine —The observers stand on an elevating platform

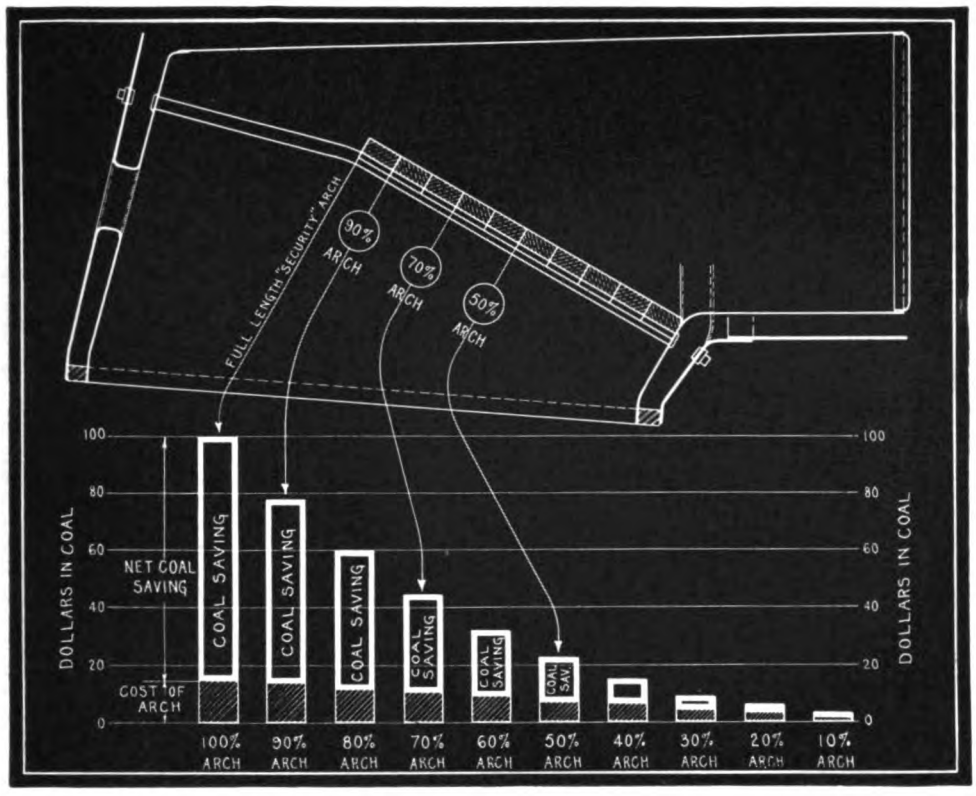
The overall height of the machine is 40 ft. 4 in., of which 25 ft. is above the floor line, the rest below. It is 16 ft. 4 in. wide and 9 ft. front to back. There is ample space available for testing. In compression testing, 90 in. is available from right to left and 108 in. from front to back, with a maximum height of 186 in. In tension testing, a similar space is available from left to right, with a maximum height of 150 in. plus a 36 in. stroke. Dimensions from front to back are not given, because theoretically these dimensions are infinite. The main ram is 46 in. in diameter and has a 36 in. stroke. The pullback rams are 12 in. in diameter. While the hydraulic stroke has a maximum range of 36 in., the heads of the machine can be adjusted over the full height by means of a 50-hp. motor. The motor rotates screws on either side of the machine to effect the desired position of the head.

The Templin machine is capable of weighing a load of three million pounds with an error less than two parts in a thousand and has a sensitivity such that the weight of a man moves the indicator over nearly ¼ in. of arc in the low range.

Pool-Purchase of Covered Hopper Cars Being Investigated

THE Western Association of Railway Executives is investigating the feasibility of a pool-purchase of large quantities of standardized covered hopper cars. The study does not involve the pooling of

(*Continued on next left-hand page*)



THE EFFECT OF ABBREVIATED ARCHES ON FUEL SAVING

LET THE ARCH HELP YOU SAVE

With the emphasis being placed on saving every railroad dollar, the locomotive Arch becomes increasingly important.

Regardless of the amount of traffic handled, the locomotive Arch saves enough fuel to pay for itself ten times over.

Be sure that every locomotive leaving the roundhouse has its Arch complete with not a single brick nor a single course missing.

In this way, you will get more work for each dollar of fuel expense. Skimping on Arch Brick results in a net loss to the railroad.

THERE'S MORE TO SECURITY ARCHES THAN JUST BRICK

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Refractory Specialists



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Locomotive Combustion Specialists

ownership or operation. The purpose of the study is to determine what advantages will result if several railroads purchase the same type of car at the same time. Thus far a committee made up of representatives of several railroads has decided upon a standard design and the association has received bids from the car builders on lots of 500 cars and more. After the bids are analyzed the association will present its findings to member roads for action. At the present time, eight railroads are definitely interested and more are expected to participate if the pool-purchase plan offers substantial inducement.

"Modern Pioneers" in Railroading

"MODERN PIONEER" certificates were received by some 500 nominees during February at regional dinners sponsored by the National Association of Manufacturers to commemorate the 150th anniversary of the American patent system. Dinners were held in 14 industrial communities throughout the country, the last dinner being held at New York on February 27 when national awards were also made. An evaluation of the regional awards received by those honored for their contributions in the railroad and railway supply fields follows.

William J. Besler, vice-president and general manager, Besler Systems, Emeryville, Calif., has been a director and active participant in research in high-pressure steam for the past seven years. He has been granted five patents for his work in this connection and has nine other applications pending. He also has eight patents on vacuum power brakes and two pending. The power plant sold by the Besler company to the New York, New Haven & Hartford is now in its fourth year of operation.

Tracy V. Buckwalter, vice-president Timken Roller Bearing Company, was honored, among other things, for his notable research in the application of roller bearings to railroad locomotives and cars. Mr. Buckwalter was granted some 60 patents during his 16 years of service with the Pennsylvania as an employee in the Altoona electric shops (1900-1906) and in charge of automotive engineering, office of general superintendent motive power (1906-1916), and about 100 additional patents during his connection with Timken as chief engineer (1916-1922) and vice-president.

His achievements during direct railroad service centered about the development of electric shop and platform trucks, storage battery locomotives and equipment for rail-highway service.

As a Timken officer, Mr. Buckwalter's activities have been concentrated on the application and manufacture of tapered roller bearings. After successfully adapting such bearings to varied industrial machines and highway vehicles, he joined, in 1929 in designing Timken locomotive No. 1111, which was equipped with roller bearings on all axles and "loaned" to the carriers for demonstration. Mr. Buckwalter was also attracted to the problem of track damage from the unbalanced inertia forces of locomotive reciprocating parts and succeeded in designing die-forged, alloy-steel members for piston, piston-rod and cross-head assembly having about one-half the conventional weight.

Charles A. Campbell, engineer of tests, New York Air Brake Company, who was honored at Rochester, N. Y., is the recipient of a total of 123 patents issued to him solely or jointly and has entered application for 16 additional grants. His most outstanding contribution to railroading may be said to be the development of a graduating type of retardation controller, known commercially as the Declekron, and the electro-pneumatic straight-air controlled brake system with which it functions. This type of braking has made possible the safe operation of high-speed, light-weight trains by improving stopping distance without requiring a higher maximum coefficient of adhesion between wheel and rail. Other of Mr. Campbell's patents have influenced to a marked degree the construction and function of the modern air brake for railroad freight trains. This equipment, known as the AB brake, has been adopted by the railroads for application to all cars in interchange service by 1945. Its adoption followed many years of investigation by the Interstate Commerce Commission and the Association of American Railroads directed toward the discovery and development of a satisfactory brake for long freight trains.

George H. Emerson, chief of motive power and equipment, Baltimore & Ohio, was named a "Modern Pioneer" for his single-drum locomotive water-tube firebox boiler, a description of which appeared in the August, 1931, issue of the *Railway Mechanical Engineer,* page 397. Many other of Mr. Emerson's patents are in use on the B. & O.

Clyde C. Farmer, director of engineering for the Westinghouse Air Brake Company, received a scroll for his invention and development of the "AB" air brake for freight service, for which he has been granted the basic patent covering the principal characteristics and 24 supplementary patents. Mr. Farmer has been granted some 458 patents and was awarded the George R. Henderson Medal by the Franklin Institute in 1938 "for meritorious inventions and discoveries in the field of railway engineering."

Thomas C. McBride and *John F. Grace,* Worthington Pump and Machinery Corporation, Philadelphia, Pa., and Harrison, N. J., respectively, were cited for their various inventions in connection with feedwater heaters and condensers. Mr. McBride was specifically cited for his design of the open-type locomotive feedwater heating system.

George McCormick, general superintendent, and *Frank E. Russell,* mechanical engineer, Southern Pacific, received a joint award for research work done in collaboration. They were cited chiefly for their joint patent for a fusible boiler drop plug, which prevents boiler explosions due to lower water. Mr. McCormick has also received patent grants for a removable driving box; a driving tire retainer; a wheel cooler and several patents for new methods of lubrication. Mr. Russell has received patents for a throttle lever mechanism; a combined body bolster and draw casting and an uncoupling-shaft locking device. Both Mr. McCormick and Mr. Russell have a joint application pending for the improvement of locomotive crank pins and bearings with respect to lubrication.

J. J. Tatum, assistant chief motive power and equipment, Baltimore & Ohio, received his scroll for the use of rubber in passenger-car trucks. His patents cover a wide variety of devices for improving passenger-car design and riding comfort, freight-car trucks, center-sill construction, etc.

W. E. Woodard, vice-president, Lima Locomotive Works, Inc., received his scroll at New York. His most notable contribution to the science of railroading was probably the Lima-built 2-8-2 type locomotive No. 8000 for the Michigan Central described on page 497 of the September, 1922, *Railway Mechanical Engineer.* In this design the fundamental aim was to produce maximum drawbar horsepower for a given driving-axle load, the yardstick for locomotive construction prior to this development having been tractive force. The leveling device for subway cars adopted by the New York subway systems is an invention of Mr. Woodard, as is also the poppet valve gear for use on American railroads described on page 349 of the September 1939, *Railway Mechanical Engineer.* Mr. Woodard has been granted some 80 patents during his career and 11 additional issued jointly to himself and co-inventors. At present he has five patent applications pending in his own name and one in joint application.

Equipment Purchasing and Modernization Programs

Atchison, Topeka & Santa Fe.—The Santa Fe is considering the purchase of Diesel-electric passenger locomotives.

Atlantic Coast Line.—The A. C. L. is rebuilding 1,000 box cars in its shops at Waycross, Ga. These cars were originally built with steel frames and the company is now applying steel sides and U-section truck sides.

Chicago, Milwaukee, St. Paul & Pacific.—The Milwaukee is considering the acquisition of 16 heavy yard and two lightweight branch-line Diesel-electric locomotives.

Colorado & Southern-Ft. Worth & Denver City.—Division 4 of the Interstate Commerce Commission, with Commissioner Porter dissenting, has approved loans of $619,500 to each of these companies by the Reconstruction Finance Corporation. The loans will be used to help finance the purchase of new equipment and will be evidenced by equipment notes bearing interest at the rate of three per cent per year and maturing serially over a period of 10 years in annual installments of approximately equal amounts.

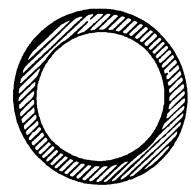
The proceeds will be used for the purchase by each company of a 4,000-hp. Diesel-electric, high-speed locomotive, one diner-lounge car, one mail-baggage car, and one combination baggage-passenger car at a cost of $376,000 for the locomotive and $243,500 for the cars. The two companies will use the new equipment, together with stainless-steel streamline coaches which they now have, to run two streamlined trains in overnight service between Denver, Colo., and Dallas, Texas.

Louisiana & Arkansas.—The Louisiana & Arkansas has asked the Interstate Com-

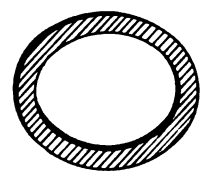
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Flow of Steam to the Cylinders ... through the SUPERHEATER

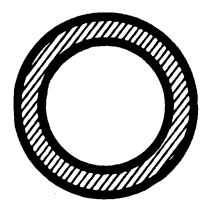
Cross-Sectional Area
of Superheater Unit Tube
1½-in. O.D. Units, #10 B.W.G. Thick



Correct Shape (1)
Full Area—1.14 sq. in.



Flattened ⅛"
Effective Area—1.1163 sq. in., or a
2.1% Reduction



1/16" Welding
Effective Area—0.9144 sq. in., or a
19.8% Reduction

(1) Steam areas through Elesco Superheater Units, whether new or REmanufactured, are full and unobstructed in their entirety. Have unserviceable superheater units REmanufactured—NOT REPAIRED.

THE SUPERHEATER COMPANY

Representative of AMERICAN THROTTLE COMPANY, INC.
60 East 42nd Street, NEW YORK 122 S. Michigan Ave., CHICAGO
Canada: THE SUPERHEATER COMPANY, LTD., MONTREAL

ELESCO
A-1394

Superheaters « Exhaust Steam Injectors « Feedwater Heaters « American Throttles « Pyrometers « Steam Dryers

merce Commission for authority to assume liability for $1,536,000 of three per cent equipment trust certificates of 1940, maturing in the amount of $52,000 on September 1, 1940, and a like amount on March 1 and September 1 of each year thereafter up to and including March 1, 1943, and $51,000 on September 1, 1943, and a like amount on March 1 and September 1 of each year thereafter up to and including March 1, 1955. The proceeds will be used in part to pay the American Car and Foundry Company for construction and delivery at East St. Louis, Ill., of 300 steel-sheathed 50-ton box cars, costing $834,714, the orders for which were announced in the November, 1939 issue of the *Railway Mechanical Engineer*. Part of the proceeds will also be used to pay for 255 all-steel 70-ton flat cars with bulkheads, built for the transportation of wood pulp, which have already been received from A. C. F. The company also desires to purchase with these funds eight used oil-burning freight locomotives and one used modernized switching locomotive from the Kansas City Southern.

Norfolk & Western.—An improvement program to be carried out by the Norfolk & Western at Lambert Point, Va., includes a new 1,100-car capacity coal classification and storage yard and a new 200-car capacity car repair yard with modern buildings and other facilities. The total cost will be about $500,000. The new classification yard will be on the site of the present car-repair yard and will have 29 additional tracks, a total mileage of about 13 miles with a capacity of from 33 to 47 cars each. The tracks will be built parallel to the present classification yard and will be connected at both ends. The new car-repair yard will have 10 tracks, aggregating about 4½ miles; a new 150-ton track scale and seven modern new buildings, including an oil house, paint house, air-brake house, office and locker room, as well as a storehouse, machine and smith shop, planing mill and lumber shed.

Wabash.—The Wabash has been authorized by the federal district court to spend $746,352, of which $128,555 is for passenger-car improvements.

Western Maryland—The Western Maryland, having certain trucks and other equipment available, placed orders in the latter part of 1939 for sufficient items to complete the assembling of 30 caboose cars in its own shops.

Western Pacific.—The Western Pacific has asked the Federal District Court at San Francisco, Cal., for permission to spend $636,600 as its share of the cost of new lightweight, stainless steel, head-end cars for the Exposition Flyer, operated jointly with the Chicago, Burlington & Quincy and the Denver & Rio Grande Western between Chicago and San Francisco. A similar petition filed by the Rio Grande with the District Court at Denver, Colo., and seeking authority to spend $390,000 was denied on January 13, but the Rio Grande will endeavor to have the decision reversed if permission to participate in the purchase of new cars is granted the Western Pacific. The Burlington's proportion of the cost would be $669,000. The proposed equipment includes baggage, chair and dinette-chair cars.

Three Pendulum Type Cars Being Constructed

CONSTRUCTION of three pendulum type passenger cars, one each for the Atchison, Topeka & Sante Fe, the Great Northern and the Chicago, Burlington & Quincy, has been started by the Pacific Railway Equipment Company. Early development work on this type of equipment was sponsored by C. T. Hill, son of Louis W. Hill, retired chairman of the Great Northern. It culminated about two years ago in an articulated two-car unit, the principal interest in which centers about the suspension system or method of mounting the car on the truck. The design departs completely from standard practice in that the car body is suspended from the truck, floating on soft vertical coil springs in a plane above the center of gravity of the body. The springs permit, through horizontal deflection, all of the necessary truck motion relative to the body, the motion being positioned and controlled by a pair of horizontal links elastically restrained by rubber, acting between the body and the truck frame at a height well above the body center of gravity.

The Atchison, Topeka & Santa Fe cooperated in the early development to the extent of providing motive power and testing facilities. When the new cars are completed later this year they will be operated by the owning roads as a single train in experimental service.

Jurisdictional Disputes To Be Settled by Shop Crafts

PLANS for settling jurisdictional disputes among themselves without interruption of service and without calling upon railway management to intervene were put into effect on February 15 by six of the seven shop-craft unions affiliated with the Railway Employees' Department, American Federation of Labor. The electrical workers did not subscribe to the plan which was announced by B. M. Jewell, president of the Railway Employees' Department, A. F. of L., and hailed in "Labor," organ of the railroad brotherhoods as "an important step toward peaceful adjustment of jurisdictional disputes between shopcraft unions on the railroads."

Mr. Jewell explained that the new machinery is the result of 13 years of effort by the executive council of the department. "Essence of the plan," he said, "is that employers shall not be called upon, nor permitted, nor requested to settle disputes between the unions. Nor shall an employer's work be interfered with because of jurisdictional disputes. It is the right and obligation of the organizations involved to settle such controversies among themselves."

Orders and Inquiries for New Equipment Placed Since the Closing of the February Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Loco.	Builder
Northern Pacific	1	660-hp. Diesel-elec.	Baldwin Loco. Wks.
	3	1,000-hp. Diesel-elec.	Electro-Motive Corp.
Oliver Iron Mining Co.	3	Diesel-elec.	Baldwin Loco. Wks.
	7	Diesel-elec.	American Loco. Co.
Wabash	1	660-hp. Diesel-elec.	American Loco. Co.
	1	660-hp. Diesel-elec.	Electro-Motive Corp.

LOCOMOTIVE INQUIRIES

New York Central	25	4-8-2	

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Atchison, Topeka & Santa Fe	27	100-ton ore	Pressed Steel Car Co.
General American Trans. Co.	500	Refrigerator	Company shops
New York Central	500	70-ton hopper	Despatch Shops, Inc.
New York, Chicago & St. Louis	50	70-ton hopper	American Car & Foundry Co.
	10	Gondola type container cars	Pullman-Std. Car Mfg. Co.
	110	Steel container	
St. Louis Refrigerator Car Co.	25	Refrigerator	Company shops
U. S. War Dept., Chief of Engineers	24	40-ton box	Greenville Steel Car Co.
	6	40-ton flat	Haffner-Thrall Car Co.

FREIGHT-CAR INQUIRIES

Chicago, Burlington & Quincy	50	50-ton box
Denver & Rio Grande Western	10	Caboose
Gulf, Mobile & Northern	1,000	40-ton box
	200	70-ton hopper
	250	50-ton hopper
National Tube Co.	2	70-ton gondola
	6	70-ton hopper
New York Central	1,000	Freight
Tennessee Copper Co.	8	50-ton air-dump

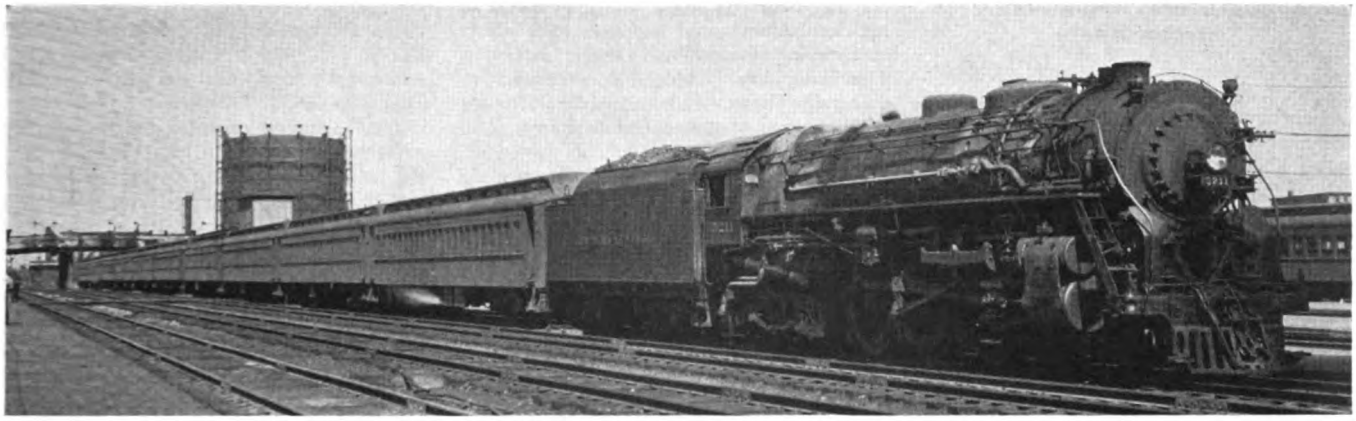
PASSENGER-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Ft. Worth & Denver City and Colorado Southern		Equipment for 2 trains—See Note [1]	
	1	Diner-lounge	[2] Edward G. Budd Mfg. Co.
	3	Coaches	
	1	Baggage	

[1] Equipment for Zephyrs 11 and 12, the Texas Zephyrs, will be placed in service this summer by the F. W. and D. C. and Colo. Sou. (subsidiaries of the C. B. & Q.), between Dallas, Tex., and Ft. Worth and Denver, Colo. The two units comprising each of the 4,000-hp. Diesel-electric locomotive will be built by the Electro-Motive Corporation. The stainless-steel mail-express car, the baggage-coach, the two de luxe chair, and the dining-lounge cars will be built by the Edward G. Budd Manufacturing Company. The remaining three cars of the 10 units, which will comprise each train, will be standard Pullman sleeping cars.

[2] These five stainless-steel passenger cars will be used on principal trains operating out of Chicago.

(Turn to next left-hand page)



This conventional ten car passenger train was used in tests.

7410-MILE ROAD TESTS

scientifically prove value of

WAUGHMAT

TWIN CUSHIONS

Instrument records of exhaustive tests reveal, in indisputable form, the comparative values of Twin Cushions, Friction Draft Gears and other arrangements in eliminating and reducing jerks and jars, horizontal, lateral and vertical shocks, surging, and stresses in the draft gear yoke and coupler shank. Report now ready for personal presentation to technical executives.

WAUGH EQUIPMENT COMPANY

NEW YORK **CHICAGO** **ST. LOUIS**

Canadian Waugh Equipment Company, Ltd., Montreal

Engineers' Report on Streamliners

THE statistics of 100 "streamline, lightweight, high-speed passenger trains" show without doubt that they are highly popular and proved financial successes, according to an 82-page report prepared by Coverdale & Colpitts, consulting engineers, New York, for the Edward G. Budd Manufacturing Company, Philadelphia, Pa. Covering traffic and earnings statistics of selected trains for the years ended June 30, 1938, and 1939, the report has been made for the purpose of bringing the figures of a basic report dated June, 1938, (reviewed in the December 1938, *Railway Mechanical Engineer*, page 499) down to June 30, 1939. Classification of material and methods of analysis are similar in both reports, and the preparatory discussion of the field of streamliners is repeated exactly in this latest "edition."

For each train touched on, the report gives a short history, details of consist, seating capacity, etc., characteristics of regular routes, speed averages and, where obtainable, revenue and traffic statistics. The latter are lacking for a number of the trains, however, because the railroads do not segregate the applicable figures from total train returns.

Statements of revenues and expenses do not include the items of interest, depreciation, taxes or insurance, since these overhead charges are not directly assignable to train operation. For a similar reason, terminal rentals are also omitted from the calculations.

The report credits the rapid extension and improvement of streamliners to a number of organizations. Pullman-Standard Car Manufacturing Company and the Edward G. Budd Manufacturing Company are cited as leaders in new car construction; the Electro-Motive Corporation for its development of the Diesel two-cycle engine practicable for high-speed locomotives and the Union Pacific, Chicago & North Western, Southern Pacific, Chicago, Burlington & Quincy, Atchison, Topeka & Santa Fe and the Chicago, Rock Island & Pacific for their promotion of modern passenger-train equipment on their respective lines.

The Santa Fe operated the largest fleet of streamliners as of June, 1939, according to the report. Amounting to 15 separate trains, they consisted of a total of 61 cars. The two Daylights of the Southern Pacific operating between Los Angeles, Cal., and San Francisco, earned $5.28 per train-mile during the year ended June 30, 1939, which exceeds the "take" of any other train during the period covered in the report. The Daylights also enjoyed exceptionally high net earnings—$3.85—or 72.9 per cent of gross revenues.

The highest ratio of net revenues to gross of any train in the report is found in the figures for the two Afternoon Hiawathas of the Chicago, Milwaukee, St. Paul & Pacific, which cleared 75.7 per cent of gross for the year ended June 30, 1938, and 75.3 per cent in the following year.

Supply Trade Notes

F. M. HUFFMAN, assistant manager of sales at Baltimore, Md., of the Bethlehem Steel Company, has been appointed assistant general traffic manager, with headquarters at Bethlehem, Pa.

◆

FRANK J. DOLAN, assistant secretary and assistant treasurer of The Superheater Company, has in addition to these duties, been appointed assistant to vice-president, sales, with headquarters at New York.

◆

H. C. SAUER, manager of the Chicago branch of the service-sales division of the Timken Roller Bearing Company, Canton, Ohio, has been transferred to New York to succeed J. W. Berriman, who has been granted a leave of absence. L. J. Halderman, manager of the Kansas City, Mo., branch, has been transferred to Chicago and has been succeeded by F. A. Weisenberger.

◆

C. H. MCGRATH, general purchasing agent of The American Brake Shoe & Foundry Co., New York, has been appointed assistant to the president and W. T. Kelly, Jr., assistant to general purchasing agent has been appointed general purchasing agent, reporting directly to the president, succeeding Mr. McGrath.

◆

JOSEPH T. RYERSON & SON, INC., Chicago, has completed a reconstruction and expansion program at its plant in Philadelphia whereby floor space has been increased 250,000 sq. ft. The improvements include a high-bay type mill building 185 ft. by 120 ft. and a finished products building with 20,000 sq. ft. of storage space as well as modern cutting equipment, a new heating plant and office improvements.

◆

HAROLD S. BROOKS, assistant to vice-president and manager of sales of W. H. Miner, Inc., Chicago, has been appointed sales manager succeeding William E. Robertson, vice-president and manager of sales, who died on January 31. Mr. Brooks was born in Prescott, Ark., on February 10, 1893, and attended Lewis Institute, Chicago. In 1914 he entered the employ of the Van Dorn Coupler Company, Chicago, as private secretary to the president, and later worked in the mechanical and sales departments. During the World War he was in the U. S. Navy. In 1919 he returned to the Van Dorn Company as manager of its Chicago sales office, and later was promoted to general manager. In April, 1923, he entered the employ of W. H. Miner, Inc., serving in the testing laboratory and other branches of the mechanical department until 1927 when he entered the sales department of that company, later being made assistant to the vice-president and manager of sales.



Harold S. Brooks

◆

FRANK W. LAMPTON, representative in the southwest of the Hunt-Spiller Manufacturing Corporation, Boston, Mass., has been appointed assistant sales manager, and Kenneth A. Craig, locomotive inspector of the Kansas City Southern, has been appointed representative of Hunt-Spiller in the territory formerly covered by Mr. Lampton. Mr. Lampton served his machinist apprenticeship with the St. Louis-San Francisco, and from 1916 to 1923 as foreman at various places on the system. He was then appointed general foreman at Springfield, Mo., serving until January 1, 1926, when he was appointed representative of the Hunt-Spiller Manufacturing Corporation. Mr. Craig took an engineering course at the Carnegie Institute of Technology, Pittsburgh, Pa. He entered the employ of the Erie in 1918 as machinist apprentice and later served, consecutively, as junior valuation engineer and chief dynamometer and track inspection car operator, having charge of all road tests. In February, 1928, he went to the Kansas City Southern as dynamometer engineer, in charge of road and locomotive tests. He was appointed traveling locomotive inspector in 1937, and during the past year has had charge of operation and maintenance of Diesel-electric locomotives.

◆

AMERICAN LOCOMOTIVE COMPANY.—William C. Dickerman has been elected chairman of the board; Duncan W. Fraser, president, and Robert B. McColl, vice-president, manufacturing of the American Locomotive Company. Mr. Dickerman was formerly president; Mr. Fraser, vice-president, and Mr. McColl, vice-president, Alco Products Division.

William Carter Dickerman, chairman of the board, was born on December 12, 1874, at Bethlehem, Pa. Following his graduation from Lehigh University in 1896 he entered the employ of the Milton Car Works, Milton, Pa., where he served successively in the auditing, purchasing and

engineering departments. In 1899, on formation of the American Car and Foundry Company, of which the Milton Car Works became a part, he was appointed assistant manager of the Milton, Pa., district. Transferred to New York in 1900, he was appointed sales agent, and later general sales



W. C. Dickerman

agent, in which position he remained until 1905 when he became vice-president. During the war Mr. Dickerman was in charge of the division of the American Car and Foundry Company which executed munition contracts on behalf of the United States and the allied nations. In 1919 he became vice-president in charge of all operations of that company, and in 1929 was elected president of the American Locomotive Company. Mr. Dickerman is a member of the Executive Committee and a director of the following companies: American Car and Foundry Company, American Car and Foundry Export Company, American Car and Foundry Securities Corporation, Carter Carburetor Co., General Steel Castings Corporation, J. G. Brill Company, and Montreal Locomotive Works. He is chairman of the board of directors and chairman of the executive committee of the Transamerican Construction Company; a director of the American Canadian Properties Corporation, the American Car and Foundry Motors Company, the Brill Corporation, First Milton (Pa.) National Bank, the Flannery Bolt Company, the Shippers Car Line Corporation, and Superheater Company, the United Gas Improvement Company; chairman of the board, member of the executive committee and a director of the American Locomotive Company; president and director of the American Locomotive Sales Corporation; president and a member of the executive committee The Guild of Brackett Lecturers (Princeton University); a trustee of Lehigh University where he recently received the honorary degree of Doctor of Engineering; a director of the Southampton (L. I.) Hospital Association; a member of the U. S. Chamber of Commerce; a member of the Chamber of Commerce of the State of New York. His memberships in other organizations include the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, the Newcomen Society, etc.

Duncan W. Fraser, president of the American Locomotive Company, was born in Pictou County, Nova Scotia. He served his apprenticeship at the Rhode Island Locomotive Works. In 1904, when the American Locomotive Company acquired the Montreal Locomotive Works, Ltd., Mr. Fraser was transferred to the Montreal Works where he served in various capacities, including that of works manager and managing director. In 1920 he became vice-president of the American Locomotive Company, with headquarters at New York. In 1924 he became a director and in 1939



D. W. Fraser

a member of the Executive Committee, and now succeeds Mr. Dickerman as president of the company. Mr. Fraser is vice-president and director of the Montreal Locomotive Works, a member of the Executive Committee and a director of the American Locomotive Company, the General Steel Castings Corporation, and the Canada Iron Foundries, Ltd. He is also a member of the executive committee and a director of the Dominion Steel and Coal Corporation, Ltd., and the Dominion Coal Company, Ltd., and a director of their affiliated companies.

Robert B. McColl, vice-president, manufacturing, of the American Locomotive Company, was born in 1882 at Kilmarnock, Scotland, where he attended the Kilmarnock Academy and the Science and Art College. After serving a special apprenticeship and working in various departments on the Glasgow & Southwestern, he was employed by Robert Stephenson & Sons, locomotive builders, Darlington, England, as a draftsman. In 1905 he went to the Montreal Locomotive Works, Ltd., Montreal, and served in several departments, becoming assistant superintendent, then superintendent of works, and finally works manager. In 1917 he was appointed manager of the munitions department of the Eddystone Munition Company. After the armistice he returned to England and was appointed general manager of the locomotive department of the Armstrong Whitworth Company, in charge of the building and equipping of the locomotive works and of the sales, engineering and manufacturing of locomotives. Later, he became also general manager of the pneumatic tool department, gas and oil engine department, and director of the Works Board of all the company's plants which included shipbuilding and the construction of Diesel oil engines for marine work, etc. He came to the New York office of the American Locomotive Company in January, 1922, and in the following June was appointed assistant manager of the Schenectady (N. Y.) plant. In January, 1925, he became manager of the plant, and in 1931 was elected president and director of the McIntosh & Seymour Corporation, Auburn, N. Y., a division of the American Locomotive Company. When the McIntosh & Seymour Corporation was merged with the parent company, Mr. McColl was named vice-president of the American Locomotive Company, Diesel Engine Division. In 1936 he was elected president of Alco Products, Inc., a division of the American Locomotive Company. With the merger of Alco Products, Inc., with the parent company, Mr. McColl became vice-president of the American



R. B. McColl

Locomotive Company, Alco Products Division. Mr. McColl is a member of the Institute of Mechanical Engineers, London, England.

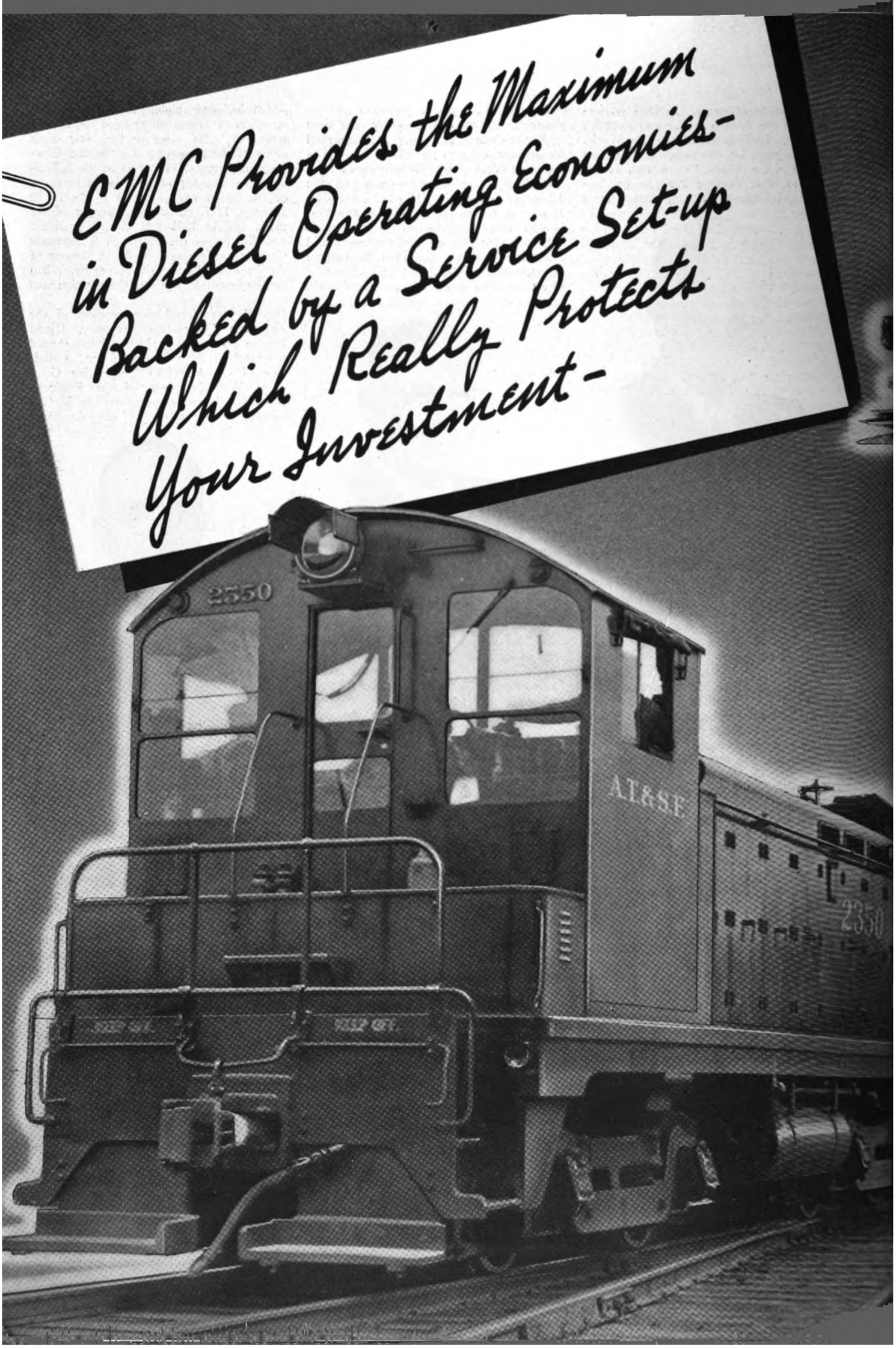
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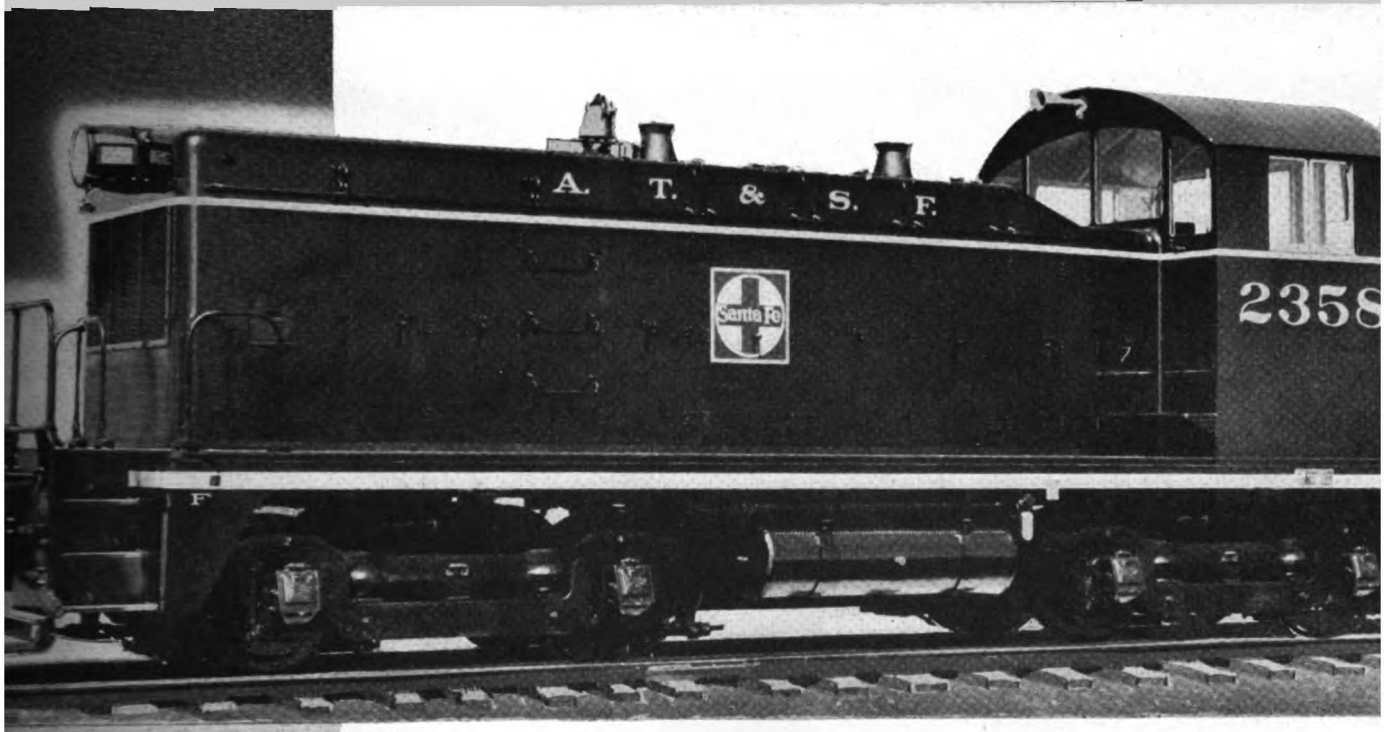
WILLIAM K. BREEZE, district sales manager at New York, of the Jones & Laughlin Steel Corporation, Pittsburgh, Pa., has been appointed Pacific Coast manager with supervision over the district offices at Los Angeles, Cal., San Francisco, and Seattle, Wash., with headquarters in Los Angeles. John B. DeWolf, district sales manager at Philadelphia, Pa., has been appointed district sales manager at New York, and Herbert B. Spackman, assistant district sales manager at Philadelphia, has been appointed district sales manager at Philadelphia.

◆

INLAND STEEL COMPANY.—Benton J. Willner and Maurice E. O'Brien have been appointed assistant vice-presidents of the Inland Steel Company, Chicago. Mr. Willner will assume the position of manager of sales of the Sheet and Strip Steel division, of which he has been assistant manager of sales since 1936. He was first affiliated with the steel industry when he joined the Inland Steel Company at its Indiana Harbor Works in 1927. Three years later he was transferred to the department of Inspection and Metallurgy at the Chicago office and became a member of the staff of

(*Continued on second left-hand page*)


EMC Provides the Maximum
in Diesel Operating Economies-
Backed by a Service Set-up
Which Really Protects
Your Investment-
2550
AT&SF
2350



GM
GENERAL MOTORS
DIESEL
POWER

WHAT EMC SERVICE MEANS TO YOU

THERE is more to consider in Electro-Motive Diesel Switchers than just low cost operation. Back of every Diesel unit stands EMC's undivided responsibility with its nationwide service,—unmatched in the motive power industry.

A complete stock of parts for all EMC Diesel power, available to all railroads 24 hours daily, is maintained at seven strategically located stores at La Grange, Illinois,—St. Louis, Missouri,—Minneapolis, Minnesota, —Newark, New Jersey,—Jacksonville, Florida,—Emeryville and Los Angeles, California. This service makes possible a reduced railroad inventory, safeguards against obsolescence and at the same time provides ample protection of motive power investment.

●

ELECTRO-MOTIVE CORPORATION
SUBSIDIARY OF GENERAL MOTORS LA GRANGE, ILLINOIS, U. S. A.

the Sheet and Strip Steel sales division in 1931. Mr. O'Brien is manager of sales, carbon steel bars and billets, the position which he has held since 1936. He became affiliated with the Inland Steel Company's sales department in 1934, prior to which time he was associated with the Illinois Steel Company.

Obituary

SAMUEL MATTHEWS VAUCLAIN, chairman of the board of The Baldwin Locomotive Works since 1929 and associated with that organization since 1883, died of heart disease at his home in Rosemont, Pa., on February 4, at the age of 83, after a lingering illness. Mr. Vauclain was born in Philadelphia, Pa., on May 18, 1856. Shortly thereafter his father, who had been in the employ of Matthias W. Baldwin (founder of The Baldwin Locomotive Works) and of the Philadelphia & Reading, entered the service of the Pennsylvania and moved to Altoona, Pa., where the shops of that road were then under construction. The boy was educated at the Altoona public schools and at the age of 16 entered the employ of the Pennsylvania. At 21, his apprenticeship completed, he was made a foreman in the frame shop. In 1882, Mr. Vauclain was sent to The Baldwin Locomotive Works to inspect the construction of locomotives then being built for the Pennsylvania. As a result of this trip, he was offered a position with the Works and on July 1, 1883, entered their employ as superintendent of the Seventeenth Street Shops. In 1886, at the age of 30, he was made general superintendent of the plant, and in 1896 became a member of the firm of Burnham, Williams & Co., proprietors of the Works. In 1911, he was made vice-president of The Baldwin Locomotive Works, the company having been incorporated two years previously. He was appointed senior vice-president in 1917, and president in 1919. Ten years later, in 1929, Mr. Vauclain relinquished the presidency to George H. Houston and himself was elected chairman of the board, in which position he remained until his death. During the World War, Mr. Vauclain served as chairman of the Locomotive and Car Committee on the Council of National Defense, and also as chairman of the Special Advisory Committee on Plants and Munitions of the War Industries Board. It was during this period that he directed the supply of locomotives and munitions for participating countries and under his general direction a plant was built at Eddystone, Pa., for the manufacture of rifles. With the entrance of the United States into the World War, the entire facilities of The Baldwin Locomotive Works were placed at the disposal of the United States Government, and large orders for locomotives, ammunition and gunmounts filled.

For many years, Mr. Vauclain was a member of the board of a number of banks, insurance and civic organizations and at his death was a director of the Standard Steel Works Company, Baldwin-Southwark Corporation, Whitcomb Locomotive Company, I. P. Morris & DeLaVergne, Inc., The Federal Steel Foundry Company, Cramp Brass & Iron Foundries Co., and The Midvale Company, all Baldwin subsidiaries. He also served on the boards of the Westinghouse Electric & Manufacturing Co., and Westinghouse Electric International Company.

In view of services rendered to his own and foreign governments, Mr. Vauclain was awarded the Distinguished Service Medal by the United States government in 1919; the "Chevalier de la Legion d'Honneur Francaise" by France in 1919; "Il Cancelliere Dell' Ordine Della Corona D'Italia" by Italy in 1920, and the "Polonia Restituta" by the Polish government in 1923. He also received honorary degrees of Doc-



S. M. Vauclain

tor of Science from the University of Pennsylvania and Worcester Polytechnic Institute and the degree of Doctor of Laws from Villanova College.

Mr. Vauclain had many talents but the foundation of his career was undoubtedly his uncanny ability as a machinist and practical engineer who knew steam locomotives and shop practice "from A to Izzard." Never given to theorizing or isolated study (he forewent college because after four years it would take too much time "to catch up with progress"), he was chiefly a "chalk-and-blackboard engineer" who carried the figures in his head and quoted bids on demand.

During his 57 years' association with Baldwin's, he had in some degree to do with the design and production of many "locomotives of the future." Among the successive innovations turned out during the Vauclain era were the first "decapod" heavy freight engine for the Dom Pedro II road of Brazil (1886); the first "wagon-top" boiler for the Denver & Rio Grande and the first "Mikado" for the Nippon railway named for the Japanese Mikado (1897). His best-known contribution to railroading as a technician was undoubtedly his four-cylinder compound locomotive, first tested in 1891. But probably more important to the industry were his tireless efforts to improve step by step the method and products of locomotive manufacture. Thus, shortly after becoming general superintendent of the Baldwin Locomotive Works at the age of 30, he installed the hydraulic forge for making drive-wheel centers, a device known abroad as a theory but unapplied. A few years later he decided to reduce idle time on expensive machine tools and introduced the double-shift to Baldwin's, an industrial principle now universal but unthought of in that day. He was even too progressive for inventors. George Westinghouse laughed at his friend Sam for suggesting that machine tools be operated as units by electric motors.

Samuel Vauclain not only made locomotives; he was one of their most successful merchandisers. This *modus operandi* was based on the belief that "a sale is not completed until the buyer is satisfied." He generally went along with new locomotives to make certain of their satisfactory operation. When times were dull, he either looked to foreign fields "where commercial skies were brighter" or pepped up the domestic market with new ideas. Thus he early extended the market for Philadelphia-built locomotives to wherever ties held rails apart. Success in these ventures depended first upon his ability to convince foreign operators—often untrained politicians—that they needed Baldwin locomotives and, second, upon his faith in their honesty and ability to pay. The Roumanians won't soon forget the deal he made with Queen Marie, "the country's best business man," by which he sold $15,000,000 worth of locomotives and machinery payable in 60 monthly installments in cash or oil. The oil he sold to the British government at a handsome profit. Typical of his tactics on the home front was the so-called "Prosperity Special," a consignment of 50 heavy freight locomotives (cost $5,000,000) which he had hauled as a solid train across the continent for delivery to the Southern Pacific during the depression of 1922.

◆

JOHN B. HERMAN, sales engineer for the American Car and Foundry Company, at St. Louis, Mo., died on February 7.

◆

WILLIAM E. ROBERTSON, vice-president and manager of sales of W. H. Miner, Inc., Chicago, died on January 31. Mr.



William E. Robertson

Robertson was born at St. Albans, Vt., on April 12, 1880, and was graduated from Norwich University, Northfield, Vt. He entered the employ of the Miner Company on March 18, 1910, as a draftsman and worked in the drafting and mechanical departments until March, 1911, when he was transferred to the sales department as a salesman. Later he engaged in executive sales work; in December, 1923, was elected a director and in March, 1927, became vice-president and sales manager.

Personal Mention

General

JOHN KENNEDY, superintendent and master mechanic of the McCloud River Railroad, with headquarters at McCloud, Calif., retired on January 1.

B. H. SMITH, master mechanic of the Chicago, Rock Island & Pacific at Des Moines, Iowa, has been appointed superintendent of motive power of the Second district, with headquarters at Kansas City, Mo.

WILLIAM FERGUSON CONNAL, mechanical engineer of the Canadian National, with headquarters at Montreal, Que., has recently been appointed chief mechanical engineer, with jurisdiction over system matters. Mr. Connal was born on August 9, 1877, at Peterboro, Ont., and was graduated from McGill University at Montreal



William Ferguson Connal

in 1897. He entered railway service on August 1, 1900, as special apprentice on the Lake Shore & Michigan Southern (now a part of the New York Central) and was a consulting engineer on that road from 1903 to 1904. From the latter date until 1905 he was employed by the Canadian Pacific at Montreal. In 1905 Mr. Connal became shop superintendent of the Damascus Brake Beam Company. He was employed by the New York Central & Hudson River (now part of the New York Central) from 1907 to 1908 and from 1908 to 1915 engaged in railway construction in Canada. From 1915 until 1919 he was employed by the Canadian Government (now the Canadian National) and in March, 1919, he was appointed mechanical engineer of the Canadian National, the position he held until his recent appointment as chief mechanical engineer.

Master Mechanics and Road Foremen

GEORGE TWIST, division master mechanic of the Canadian Pacific at Nelson, B. C., has retired.

H. J. REED, general foreman on the Canadian Pacific at Revelstoke, B. C., has been appointed to the position of division master mechanic at Nelson, B. C.

Car Department

WALTER E. DUNHAM, superintendent of the car department of the Chicago & North Western and the Chicago, St. Paul, Minneapolis & Omaha, with headquarters at Chicago, who retired on February 1 as noted in the February issue, was born at Newark, N. J., on September 9, 1873, and graduated in mechanical engineering from Cornell University in 1895. He entered railway service in 1896 as a helper in the shops of the Chicago, Rock Island & Pacific at Horton, Kan., and in 1898, was advanced to the position of head draftsman in the motive power department at Chicago. Two years later, he was appointed master mechanic at Dalhart, Tex., and in 1902, entered the employ of the North Western as chief draftsman in the mechanical department at Chicago. Mr. Dunham became mechanical engineer in 1903 and in 1906 was appointed master mechanic at Winona, Minn. In 1910, he was promoted to supervisor of motive power and machinery with the same headquarters. He was appointed assistant to the general superintendent of the motive power and car department, with headquarters at Chicago in 1917, and from 1920 to 1921 served as a member of the railroad board of adjustment No. 2, returning to his former position in the latter year. He became superintendent of the car department in 1924, and in 1927 was appointed also superintendent of the car department of the



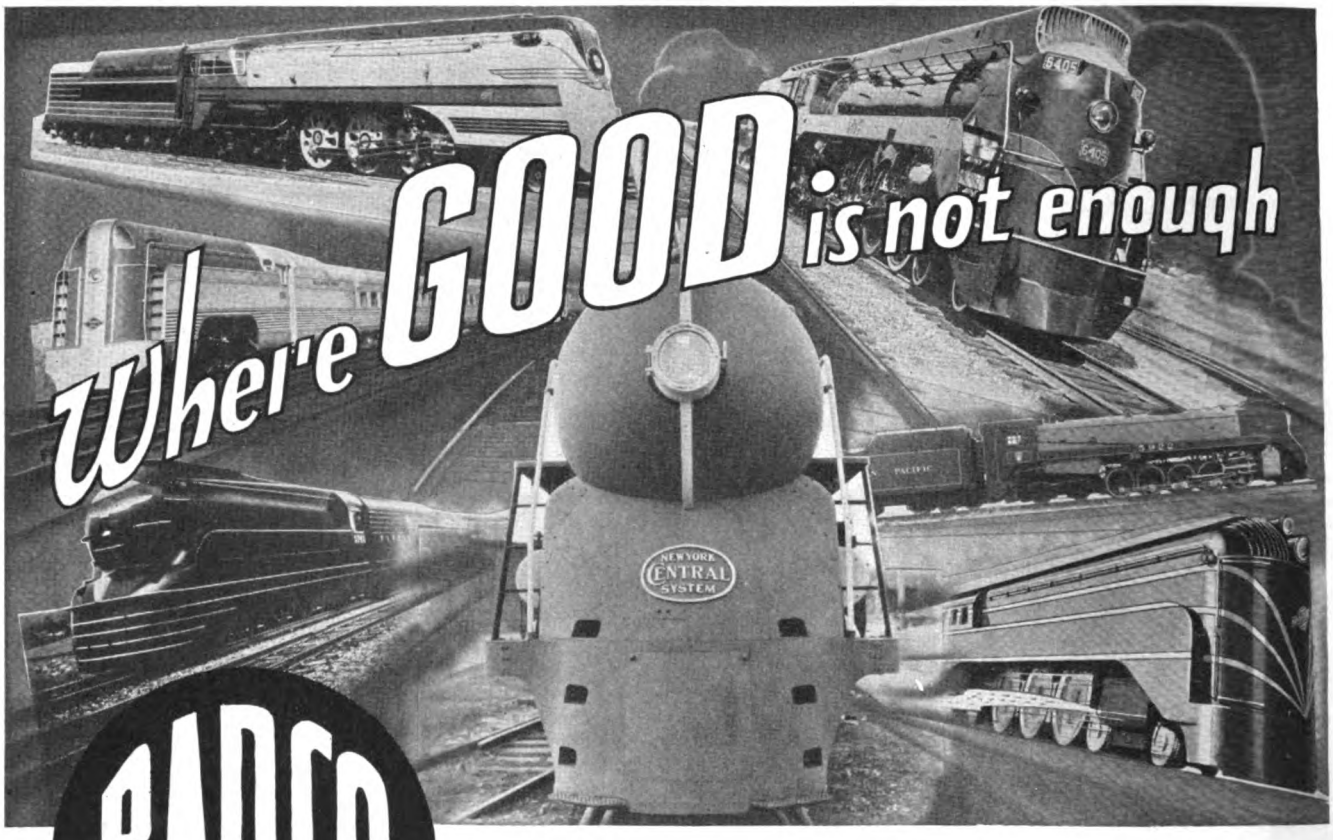
Walter E. Dunham

Chicago, St. Paul, Minneapolis & Omaha. Mr. Dunham has long been active in the work of the Association of American Railroads, Mechanical division, having served as chairman of the committees on Train Lighting and Automotive Rolling Stock. He is a past president of the Western Railway Club, a former vice-president of the Car Department Officers' Association and is at present chairman of the Transportation group, Chicago section, of the American Society of Mechanical Engineers.

L. R. WINK, assistant superintendent of the car department of the Chicago & North Western, has been appointed superintendent of the car department, with headquarters as before at Chicago, succeeding Walter E. Dunham, retired. Mr. Wink was born on January 30, 1883, and entered railway service on August 1, 1899, as a car repairer at the Chicago shops of the North Western. In 1905, he was appointed special inspector at the Chicago shops and in 1908, was promoted to foreman at the Proviso Yards. He was transferred to the Wood street freight station at Chicago in 1909, and later that year was promoted to traveling car inspector, with headquarters at Chicago. Mr. Wink was advanced to general car foreman at the Chicago shops in 1915, and in September, 1919, was promoted to the position of assistant superintendent of the car department.

Obituary

COLONEL JAMES MILLIKEN, former superintendent of motive power of the Philadelphia, Baltimore & Washington, part of the Pennsylvania System, died on February 5, at the McGirk sanatorium, Philipsburg, Pa. Colonel Milliken was born on February 19, 1865, at Newtown, Pa., and was educated at the University of Pennsylvania. He entered railway service on September 16, 1885, and served consecutively as a fireman on the Pittsburgh division of the Pennsylvania, machinist apprentice and machinist at the Altoona shops, and from January, 1890, to June, 1891, as assistant road foreman of engines on the Philadelphia division. He was then transferred to the Pittsburgh division and in February, 1892 was appointed assistant master mechanic at the Altoona shops. From August, 1895, to March, 1899, Colonel Milliken served as assistant engineer of motive power on the Philadelphia, Wilmington & Baltimore, now the Philadelphia, Baltimore & Washington, then to August, 1900, as assistant engineer of motive power on the United Railroads of New Jersey division and later, to January, 1903, as master mechanic at the Baltimore shops of the Northern Central. From June, 1903, to May, 1917, he was superintendent of motive power of the Philadelphia, Baltimore & Washington. All of the above service was with the Pennsylvania System. Colonel Milliken entered the United States War Department in May, 1917, and in October of the following year was appointed colonel of engineers. While in the army he was in charge of the design, procurement, and production of railroad equipment for the American armies in France and at the end of the war the French Republic conferred upon him the rank of Officer de la Legion d'Honneur, for distinguished service. In 1919, he served as president of the Industrial Car Manufacturers' Institute and subsequently became president of the Pittsburgh Testing Laboratories, remaining in that position until his retirement in 1929. Colonel Milliken became a member of the New York Railroad Club in October, 1895, and served as its president for the year 1917. During 1931, he was identified with Eastern Air Transport, Inc., at Brooklyn, N. Y., a division of the North American Aviation, Inc.



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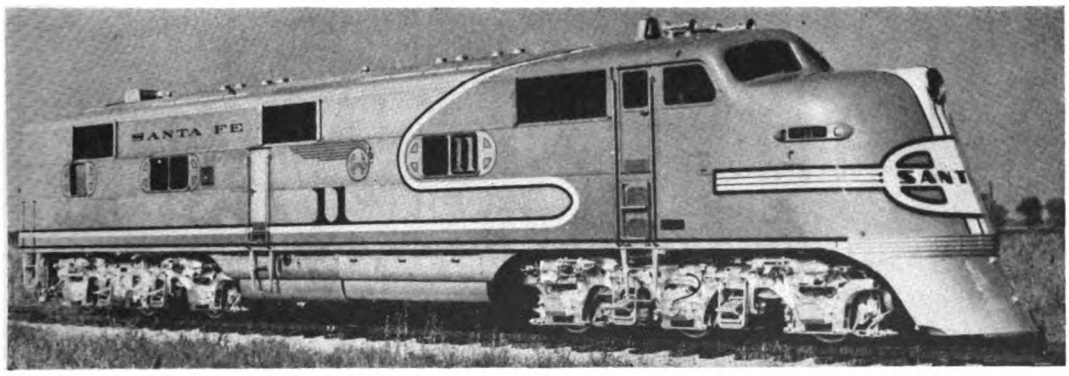
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See page 131

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Locomotive:

Design, Operation and Maintenance of Diesel Locos. ... 131
Equalizing the Flow of Air Through the Loco. Grates.. 140
A Proposed Combustion-Turbine Locomotive ... 144

Car:

Northern Pacific Hoppers ... 137
Cor-Ten Hopper Cars Show Low Weight Loss ... 149

Editorials:

Winter Weather and Brake-Rigging Failures ... 150
Locomotive Condition as Reflected by the I. C. C. Report 150
Car-Wheel Grinding Effects Economies ... 151
Cutting the Cost of Compressed Air ... 152
New Books ... 152

Car Foremen and Inspectors:

Circumstantial Evidence (A Walt Wyre Story) ... 153
Air Brake Questions and Answers ... 156
Self-Contained Dust Collector Unit ... 156
My Idea of a Stock Car ... 157
Balancing High-Speed Rotating Parts ... 158

Backshop and Enginehouse:

Canadian National Method for Lagging Application ... 161
Water Rheostat for Testing Diesel Locomotives ... 162
Locomotive Boiler Questions and Answers ... 163
Gage for Checking Fillet-Weld Size ... 165
Steam Valve With a Spinning Disc ... 165
Ram-Type Turret Lathe ... 166
Tool Opens Flanges for the Renewal of Gaskets ... 166

High Spots in Railway Affairs ... 167

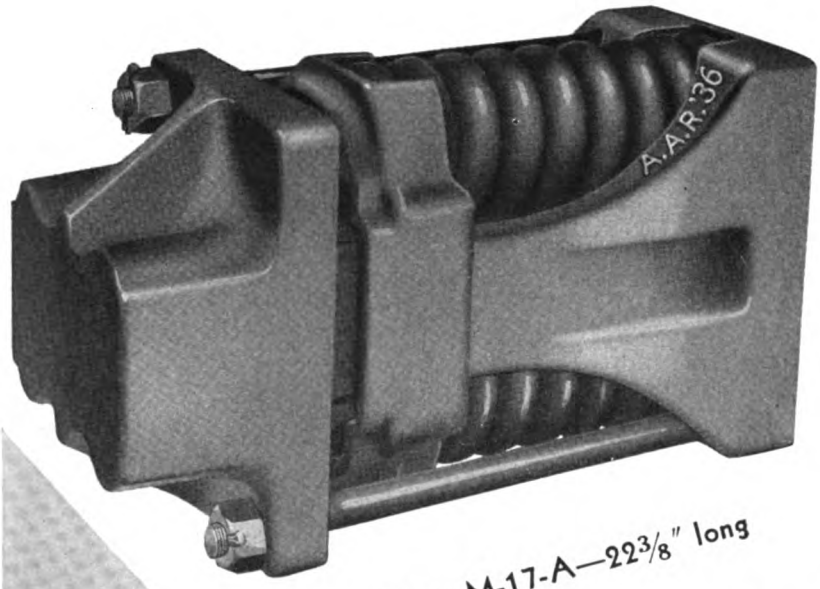
Clubs and Associations ... 168

News ... 169

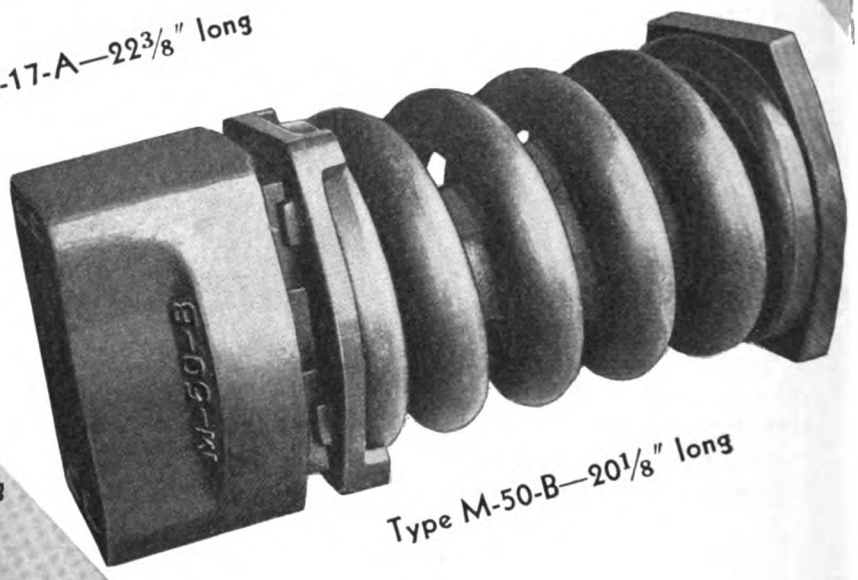
Index to Advertisers ... (Adv. Sec.) 40

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Design, Operation and Maintenance of

Diesel Locomotives*

By H. V. Gill †

Operating results and maintenance methods with 14 road locomotives and 41 switchers, aggregating 64,900 hp., outlined in this paper

During 1934, several lightweight articulated trains were built and placed in service on western railroads and proved highly successful in attracting the traveling public. They were powered with one Diesel engine located in the first car of the train and since these trains were articulated, cars could not conveniently be added to or taken from the trains. They were, therefore, not adaptable for interchange service, particularly where cars would be occupied by parties, and due to this construction could not be operated on other railroads.

The Atchison, Topeka & Santa Fe decided to purchase a Diesel-electric locomotive of sufficient horsepower to handle 14 heavyweight passenger cars on grades up to 1 per cent making the then present schedules for steam-powered passenger trains. Engineers of the Santa Fe and the Electro-Motive Corporation collaborated on this design and in November, 1935, the locomotive was delivered. It consisted of two units coupled together, having a total over-all length of 127 ft. 8 in. weighing 258 tons. The maximum speed was 98 m. p. h. using a 22:55 gear ratio. The power was supplied by four 900-hp. two-cycle Diesel engines. Also in February, 1935, a 600-hp. Diesel-electric switching locomotive was placed in service, powered with a 600-hp. four-cycle Diesel engine.

Since these two locomotives were installed, 40 additional Diesel-electric switching locomotives and 13 high-speed road passenger units have been purchased. At this date on the Santa Fe, there is a total of 64,900 Diesel hp. in service, 37,500 hp. in switching service and 27,400 hp. in high-speed passenger service.

The road passenger locomotive units are each powered with two 12-cylinder, two-cycle Diesel engines, the horsepower rating being 1,800 to 2,000-hp. per unit. The maximum speed is 117 m. p. h. using a 25:52 gear ratio. These units have accumulated 5,625,523 miles to November 1, 1939, with an availability of 95.3 per cent.

This increase in the use of Diesel-electric locomotives has occurred over a comparatively short period of time. It is, therefore, well to analyze the characteristics of the Diesel electric locomotive to point out some of the inherent advantages which explain why its use on the railroads has increased so greatly in the last five years.

Inherent Advantages of Diesel-Electric Drive

The uniform torque exerted by the electric motors at each driving axle, gives a smooth and effective application of power without undesirable shocks or jerks. The Diesel engine which constitutes the prime mover, delivers full rated horsepower at all train or locomotive speeds, the power generated reaching the driving axle through the electric transmission. The availability of Diesel-electric locomotives is high, as they do not require frequent extensive repairs, frequent watering or fueling, boiler washing or fire cleaning. In road service, repairs may be made currently, while in switching service, inspections and repairs may be made monthly. The availability of Diesel locomotives in road service on the Santa Fe, based on assigned miles, is 95.3 per cent, while for switching locomotives it is 90.6 per cent to November 1, 1939.

Due to the swivel truck and long wheel base, the elimination of reciprocating parts and low center of gravity, the Diesel locomotive is easy on the track and will operate at high sustained speeds on fast schedules. The thermal efficiency of the Diesel engine is about 27 per cent, which results in good fuel economy, resulting in fewer stops for fuel. Diesel locomotives are free from smoke, cinders and soot. Due to fewer stops required for fuel and water and infrequent stops for servicing, the Diesel-electric locomotive may be operated over much greater distances with lower top speeds to make a given schedule. Therefore, Diesel-powered trains may run on faster schedules than steam-powered trains.

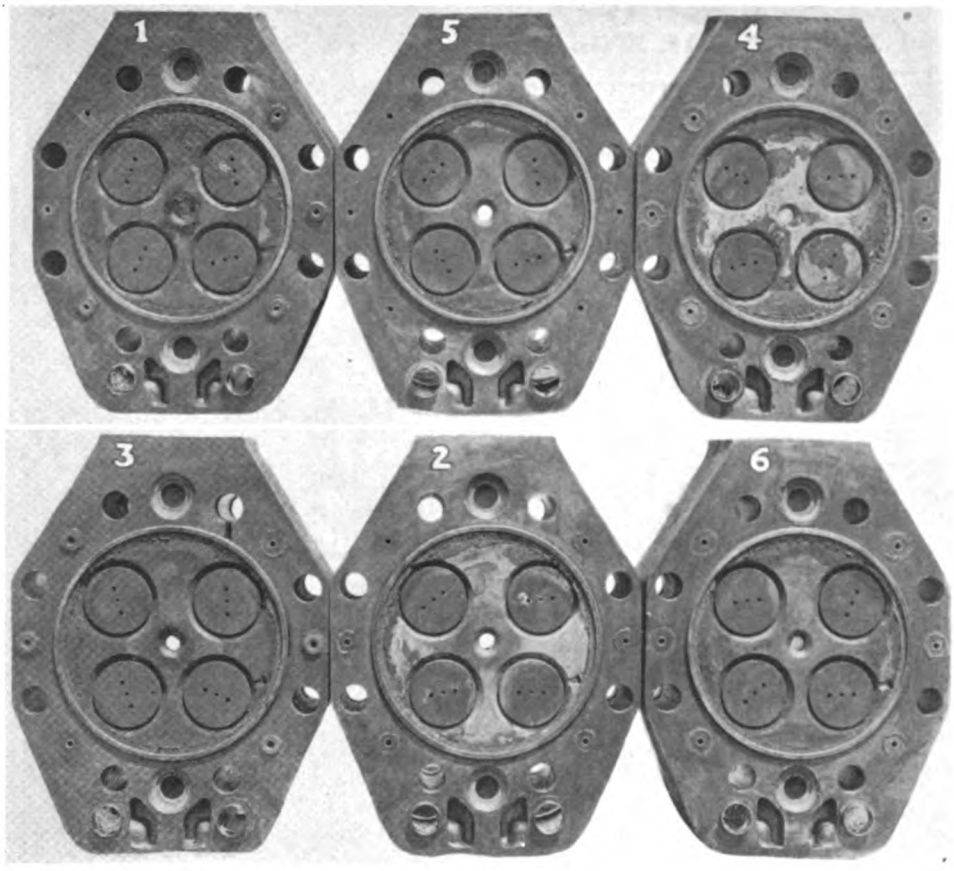
In a Diesel-electric switching locomotive, all of the weight is carried on the driving wheels, which gives an effective return for locomotive weight and since the average speed for switching operations rarely exceeds 6 or 7 m. p. h., by selecting the proper gear ratio between the traction motor and power axle (about 4:1), the Diesel-electric switcher will handle the work of a steam locomotive which has a horsepower rating of approximately two and one-half times that of the Diesel locomotive. It will operate anywhere a freight car may be handled, and after the crews become familiar with its operation, they find they can handle their work faster.

Both road and switching locomotives are easy to handle, operation by the engineman being accomplished with little physical exertion. This, combined with the features of good visibility, clean and comfortable cabs, makes them acceptable to the operating crews.

The above mentioned characteristics result in economical operation for both road and switching locomotives as indicated in cost of operation data shown in Tables I and II. These operating cost data do not include depreciation or wages of enginemen. To date it has not been necessary to give any of the Diesel locomotives general repairs.

* Abstract of a paper presented at the Truck, Bus and Rail Car meeting of the Society of Automotive Engineers, held at Los Angeles, Calif., February 9, 1940.

† Supervisor of Diesel locomotives, Atchison, Topeka & Santa Fe, Chicago.



A set of cylinder heads from a Diesel engine that had been in service for two years. The extent of the carbon accumulation may be clearly seen in the area just outside the valves—In the case of No. 1 head the accumulation was about .020 in. thick at the outer edges of the area and a minimum accumulation is seen in the case of No. 5 head. No. 2 head shows a typical condition of the water passages

Electric Transmission a Limiting Factor

The electric transmission, an important and expensive part of the Diesel equipment, at the present time is one of the limiting factors insofar as continuous operation on heavy grades is concerned. This is due to the necessity of dissipating the thermal losses from the traction motors and generators. For instance, a 4,000-hp. Diesel-electric locomotive that has a starting tractive force of 103,300 lb., and 43,000 lb. tractive force at 30 m. p. h. is limited to 26,400 lb. tractive force continuously at 40 m. p. h. Greater tractive force than the above may be developed for short periods provided the temperature limits of the electric transmission are not exceeded. A locomotive of 4,000-hp. has handled 765 tons (8 lightweight and 4 heavyweight cars) up 1.8 per cent grades on fast schedules between Chicago and Los Angeles.

In selecting or assigning Diesel-electric locomotives for service, the thermal capacity of the electric transmission must be carefully considered to make sure that it is sufficient for the duty cycle. Traction motors within the last five years have increased in capacity from 240 hp. to 500 hp. per motor, and we expect further increases in the thermal capacity and mechanical strengthening of traction motors to meet more severe duty cycles.

Since steam is required for heating and air-conditioning passenger trains, some means of supplying this demand is necessary on Diesel-electric locomotives in road service. This condition was met by the development of a steam generator. Occupying a comparatively small space, one of these generators is capable of supplying 2,250 lb. of steam per hour at 200-lb. pressure.

Liberal use is made of alloys in the design and construction of Diesel locomotives to secure maximum strength with minimum weight. Crankshafts are high carbon steel forgings, some of the bearing surfaces of which are hardened by the Tocco process. Connecting rods are alloy-steel forgings. Pistons are drop-forged aluminum or cast malleable iron. Piston pins are of high-carbon steel. Cylinder liners and cylinder heads are of cast iron. The valves are of special heat-resistant steel. Diesel engine frames and cylinder blocks are of carbon-molybdenum steel. Locomotive frames and all parts of the body that form structural supports are of carbon-molybdenum steel. Cover sheets are of stainless or USS Cor-Ten steel. Electric welding is used extensively to fabricate parts of Diesel locomotives.

Table I—Operating Cost of 3,600 Hp. Diesel-Electric Locomotives in High-Speed Passenger Service—Year 1938

	Cost per locomotive-mile
Fuel	$.0469
Locomotive repairs, labor and material	.1063
Lubrication	.0151
Supplies	.0028
Water	....
Total cost per mile	$.1711

Table II—Cost of Operation Per Service Hour in Switching Service*

	600-hp. 2-cycle Diesel-electric	600-hp. 4-cycle Diesel-electric	1,000-hp. 2-cycle Diesel-electric†	1,000-hp. 4-cycle Diesel-electric†	Steam locomotives Santa Fe 566 class
Fuel	$.199	$.290	$.247	$.275	$1.53
Locomotive repairs, labor and material	.286	.143	.129	.119	1.12
Estimated cost of general repairs	.25	.25	.25	.25	...
Enginehouse expense	.060	.046	.030	.026	1.38
Lubrication	.073	.033	.062	.019	.06
Supplies	.009	.013	.006	.008	.04
Water	...	...	...	...	.30
Total per service hour	$.877	$.775	$.724	$.697	$4.43

* These cost figures, not including depreciation, or wages of enginemen, indicate an average saving of $3.66 per service hour over steam operation in switching service.

† In service only three months.

S.D. 8-39 2M 7755

Form 1226-DS-Standard

Santa Fe

Monthly Record of Maintenance and Inspection--Diesel Switch Locomotives

Date .....
Station .....

DIESEL ENGINE—INSPECT AND REPAIR

Locomotive No._____

ITEM	WORK-MAN	ITEM	WORK-MAN	ITEM	WORK-MAN
1. Inspect crank cases		8. Check fuel system piping		15. Check injectors for tightness	
2. Check injection timing		9. Check safety cutoff valve in fuel system		16. Check water pump	
3. Check injector control linkage setting		10. Check fuel pumps		17. Check main governor	
4. Check cylinder head valve lash adjusters or valve clearance		11. Inspect pistons		18. Check overspeed governor	
5. Check cylinder heads for leaky valves		12. Check lubricating oil system		19. Inspect cooling radiators and connecting piping	
6. Inspect all vee-belt drives		13. Drain sediment from fuel tanks		20. Blow out all radiators	
7. Flush engine cooling system		14. Inspect timing chain or timing gears		21. Inspect coupling between Diesel engine and generator	

ELECTRICAL EQUIPMENT—INSPECT, TEST, REPAIR, AND CLEAN

22. Main generator		30. Check for and clear grounds		38. Traction motors	
23. Exciter generator		31. Fuel pump motors		39. Traction motor cables	
24. Auxiliary generators		32. Radiator fan motors		40. Traction motor drive gears	
25. High-voltage cabinet		33. Compressor motors		41. Engineers control station	
26. Low-voltage cabinet		34. Steam generator motors		42. Batteries	
27. Control circuits		35. Cab heater motors		43. Steam generator controls	
28. Main contactors and reverser		36. Blower fan motors		44. All wiring connections	
29. Compressor governor		37. Head and cab lights		45. Relays	
				46. Voltage Regulators	

LUBRICATION

47. Fuel pump motor		56. Drain oil in Diesel engine as instructed. Date of last oil change_____		63. Truck pedestal jaws	
48. Radiator fan motors				64. Throttle control linkage	
49. Compressor motors		57. Change oil in air compressor every 3 months		65. Drain and refill steam generator feed-water pump	
50. Steam generator motors				66. Repack waste-type traction motor armature bearings	
51. Cab heater motors		58. Main contactor and reverser air cylinders		67. Examine and repack traction motor suspension bearings as instructed	
52. Blower fan motors		59. Check oil in main governor			
53. Main generator		60. Truck journal boxes		68. Traction motor gears	
54. Auxiliary generator		61. Truck center castings		69. Roller-bearing traction motor armatures	
55. Exciter generator		62. Brake rigging			

CLEANING				SPECIAL ITEMS	
70. Diesel engine crankcases		76. Diesel engine cylinder heads		81. Inspect and test all fire extinguishers	
71. All lubricating oil strainers		77. Fuel tank filling strainers		82. Main Crankshaft Bearings Remove and examine every annual inspection of locomotive.	
72. All fuel strainers		78. Engine room			
73. All fuel filters		79. Exterior of locomotive			
74. All lubricating oil filters		80. Engineers cab			
75. All air intake filters					

ADDITIONAL INSPECTIONS

1. Air brake equipment shall be inspected and maintained as per locomotive folio and recorded on form 1154 Santa Fe standard.
2. Steam generator shall be inspected and tested as per I. C. C. requirements and report recorded on form 2532 B Santa Fe standard.
3. Running gear, draft gear and couplers, fuel system, and safety appliances shall be maintained as per I. C. C. requirements and report recorded on form 2532-A Santa Fe standard.
4. Remove and recondition all cylinder heads as per instructions.
5. Remove and recondition all piston and connecting rod assemblies as per instructions.
6. Check oil level in waste-packed traction motor bearings at least once per week.

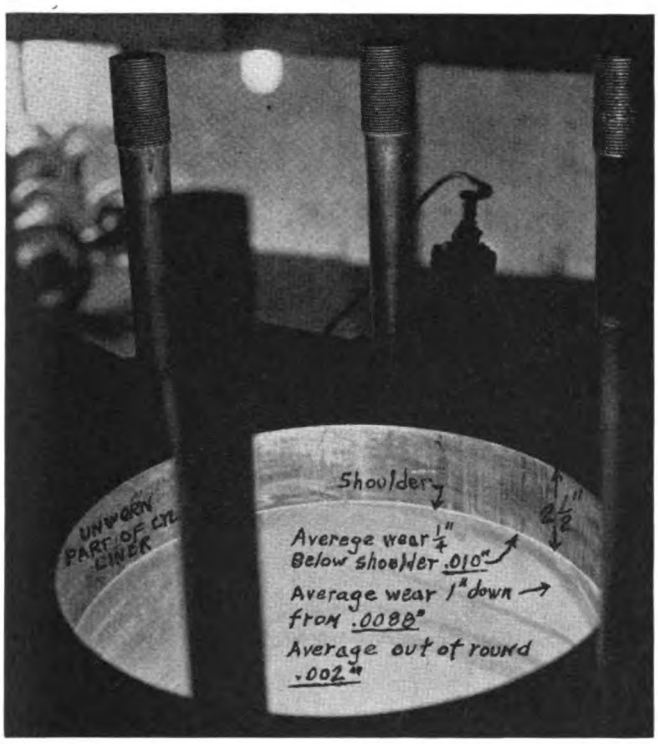
REPAIRS MADE OTHER THAN LISTED ABOVE, AND MATERIALS USED

Show serial numbers of parts removed and parts applied.

Approved by:

Foreman

Form used by the A. T. & S. F. for the monthly maintenance and inspection of Diesel-electric switching locomotives



Condition of cylinder liner after two years' service—The wear at different points is indicated

How the Equipment Is Maintained

In maintaining and operating Diesel locomotives, one of the major problems confronting all railroads is to train the personnel to handle and maintain this type of power. New facilities, tools, etc., are required.

At Chicago, the Santa Fe has built a shop especially designed for handling Diesel locomotive repairs. The shop is of the longitudinal type, 282 ft. long by 111 ft. wide. It is equipped with cranes, hoists, drop tables and machine tools. With these new facilities repairs should be expedited, resulting in greater availability for service and a reduction in maintenance costs.

Special maintenance and inspection schedules in addition to the I. C. C. requirements, have been found necessary to secure reliable economical service from the locomotives. These requirements are met by the Santa Fe standard monthly schedule Form 1226-DS for Diesel-electric switching locomotives. For road service, the Santa Fe standard schedule Form 1226-D is used. Maintenance and inspections for road service are handled on a mileage basis. A copy of Form 1226-D is carried on each respective locomotive unit: therefore, the record of maintenance and inspection is always available to maintenance forces over the system. A special instruction bulletin has been issued to cover in detail just what attention each item on forms 1226-D and 1226-DS requires.

In road service a Diesel maintainer always rides the locomotive while it is in service. These maintainers are organized on a system basis. They make a complete log

500—4-39—CPC Form 1226-D Standard

Santa Fe

DIESEL ROAD LOCOMOTIVES, RECORD OF INSPECTION AND MAINTENANCE, A. T. & S. F. RY.

Locomotive Number _____ Month of _____ Trains _____ Station _____

HANDLE EVERY 2500 MILES - ITEMS 1 TO 13 INCLUSIVE

1 Check oil level and condition of oil in all Diesel engines	2 Lubricate-Truck center plates, brake rigging, spring rigging and truck pedestal jaws.	3 Lubricate traction motor axle suspension bearings.	4 Lubricate Diesel engine water pump shafts.	5 Inspect all fire extinguishers. See that they are in good operating condition and filled.	6 Check oil level and condition of oil in truck journal boxes.	7 Lubricate traction motor drive gears.	8 Drain water and sediment from fuel and steam generator water tanks.	9 Check oil level and condition of oil in air compressors & steam generator water pumps.	10 Clean Diesel engine and air compressor, air intake filters	11 Clean all lubricating oil filters.	12 Test steam generator.	13 Inspect and thoroughly clean all traction motors
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												

HANDLE EVERY 4500 MILES - ITEMS 14 TO 26 INCLUSIVE

14 Inspect traction motor gears for worn condition.	15 Inspect Diesel engine crank case, inside and outside.	16 Inspect Diesel engine pistons and piston rings through air box.	17 Inspect all "Vee" belt drives.	18 Inspect and clean main generators.	19 Inspect and clean auxiliary and exciter generators.	20 Inspect and clean high and low voltage cabinets	21 Check for grounds and clear up all existing grounds.	22 Lubricate traction motor pinion and armature bearings. Apply 8 ounces grease	23 Inspect fuel and water tank filler opening strainers. Clean if required.	24 Flush engine cooling system and check for leaks or defective conditions	25 Inspect fire pot and clean ignition system on steam generators.	26 Inspect and clean boiler control system.
1.												
2.												
3.												
4.												
5.												

HANDLE EVERY 9000 TO 10,000 MILES - ITEMS 27 TO 39 INCLUSIVE

27 Clean and inspect all fuel pump motors.	28 Inspect and clean steam generator motors and blowers.	29 Inspect carefully traction motor cables.	30 Apply 2 to 4 ounces of grease to main generator bearings.	31 Apply 1 to 2 ounces of grease to auxiliary and exciter generator bearings.	32 Apply 1/2 ounce grease to all bearings of fuel pump motors, boiler motors, and boiler blower.	33 Apply 2 ounces of grease to traction motor blower bearings.	34 Apply 4 ounces of grease to main engine cooling fan bearings	35 Grease lightly, governor, throttle, and injector control linkage.	36 Test fuel system for leaks, and test emergency fuel shut-off valves.	37 Clean all fuel oil filters and strainers inside engine room.	38 Check injectors for looseness and for leaky condition or stuck plungers.	39 Inspect all wiring connections and wiring for looseness or worn insulation.
1.												
2.												
3.												

HANDLE EVERY 20,000 MILES - ITEMS 40 TO 52 INCLUSIVE

40 Examine all traction motor axle suspension bearings.	41 Inspect steam generator for soot accumulation on coils. Clean if required.	42 Wash out steam generator water supply tanks and suction pipes	43 Clean out the interior of all Diesel engines	44 Clean all lubricating oil strainers.	45 Test out all control circuits for proper operation.	46 Examine and lubricate speedometer generator.	47 Lubricate air cylinders of all power switches.	48 Lubricate reverser air cylinders.	49 Check exhaust valve lash adjuster settings Diesel engines.	50 Check injector timing, all Diesel engines	51 Check injector control linkage for proper adjustment.	52 Lubricate traction motor commutator end bearings. Apply 6 ounces of grease.
1.												
2.												

HANDLE EVERY 30,000 MILES				HANDLE EVERY 60,000 MILES		SPECIAL ITEMS - Fill in Headings			REMARKS:
53 Drain crank case lubricating oil from Diesel engines. No. 1 Engine	No. 2 Engine	54 Clean off top of all cylinder heads, and clean out cam pockets.	55 Inspect timing chain and show engine number	56 Drain air compressor crank case lubricating oil.	57 Drain crank case lubricating oil—Steam generator water pumps.	58	59	60	
1.									
2.									
3.									
4.									
5.									

Table III—Principal Characteristics of Diesel-Electric Locomotives now in Service on the Atchison, Topeka & Santa Fe

No. of locomotives	Manufacturer	Horsepower and class of service	Number of Diesel engines per locomotive	Weight of locomotive, lb.	Maximum speed m.p.h.	Starting tractive, lb.	Electrical Equipment
4	EMC	600 hp. switch	1	205,780	40	51,445	G E
1	BLW	660 hp. switch	1	213,840	45	53,460	A C
3	ALCO	600 hp. switch	1	196,240	40	49,060	1-GE 2-West
3	EMC	900 hp. switch	2	257,340	40	64,335	West
12	ALCO	1,000 hp. switch	1	227,900	60	57,000	G E
5	BLW	1,000 hp. switch	1	244,970	60	62,000	West
13	EMC	1,000 hp. switch	1	249,200	60	62,325	EMC
12 units	EMC	Road pass. 1,800 hp.	2	290,500	117	50,750	G E
2 units	EMC	road pass. 2,000 hp.	2	306,900	117	51,640	EMC

EMC—Electro-Motive Corporation
BLW—Baldwin Locomotive Works
ALCO—American Locomotive Company
GE—General Electric Co.
AC—Allis Chalmers Mfg. Co.
West—Westinghouse El. & Mfg. Co.

report of each trip, report to maintenance terminals all repairs and inspections required, and inspect the locomotives sufficiently in advance of departure from a terminal to insure that necessary repairs have been properly made.

Approximately 63 per cent of the repair charges to Diesel locomotives are for materials. Since these materials are expensive and changes in design are frequently made, it has become necessary to set up a special system to govern the supply of new repair parts on hand and the handling of worn or defective materials over the system. All requisitions for new materials and disposition of worn or defective parts are handled through a central point on the Santa Fe. All requisitions must be approved and periodical inventories of store department supplies are made.

A specially trained man has been assigned to follow this disposition of materials and he also keeps mileage records of locomotive performance and records of service received from cylinder heads, cylinder liners, pistons, traction motors, axles, wheels and other parts that are subject to frequent inspections or renewals.

Advantage is taken of the ability of Diesel locomotives to run for long periods without taking on fuel or water.

Table IV—Diesel Lubricating Oil Specifications

	Switching service	Road service
Gravity, Baumé	19.1	17.6
Flash, deg. F.	395	435
Fire, deg. F.	450	500
Viscosity at 210 deg. F.	62	85
Pour, deg. F.	−10	10
Ash, per cent	.003	.003
Neutralization no. per cent	.02	.02
Carbon residue, per cent	.07	.25

Switching locomotives are fueled two or three times a week while road locomotives run over 600 miles between

ADDITIONAL INSPECTIONS

1. Brake rigging, draft gear, engine room, engineer's cab, running gear and power plant shall be inspected as required and proper report made on form 2532A Santa Fe Standard.
2. Steam generators shall be inspected as required and proper report made on form 2532 B Santa Fe Standard.
3. Air brake system and signal equipment shall be inspected and tested as per standard instructions and proper report made on form 1154 Santa Fe Standard.
4. Train control, when used, shall be inspected as per standard instructions and proper report made on cab form and on form 1225 B Santa Fe Standard.
5. Main Crankshaft bearings all Diesel Engines to be inspected every 100,000 miles. 6- Locomotive must be checked for grounds in electrical equipment each trip.

TRIP MILEAGE RECORD

Locomotive Unit	Date	Train No.	Run From	Run To	Trip Mileage	Accumulated Mileage

ENGINE INSPECTION RECORD

Accumulated Mileage at time of Inspection	Date	Station	Pistons Removed	Injector Changed	Cylinder Heads	Cylinder Liners	Connecting rod Bearings	State number each item replaced and defect
			ENGINE NO 1					
			ENGINE NO 2					

TRACTION MOTORS REMOVED

Date	Remarks

WHEEL ASSEMBLYS REMOVED

Date	Remarks

Reverse side of Form 1226-D, the front of which is shown on the opposite page

fuel and water stations. For locomotives operating between Chicago and Los Angeles, a distance of 2,227.2 miles, fuel and water are taken at Newton, Kan.; Albuquerque, N. M., and at Needles, Calif. Switching locomotives are fueled during the operating crew's lunch period.

In switching service, locomotives are assigned to three shifts, 24 hours a day service, in order to take full advantage of the savings possible with this type of power. Switching locomotives give little trouble due to a low load factor—about 15 per cent.

A specially trained Diesel man is assigned to follow switching locomotives over the system. He inspects the locomotives, checks the operation and instructs maintenance forces and operating crews in proper Santa Fe practices.

Table V—Diesel Fuel Oil Specifications

Gravity, A.P.I.	28
Viscosity (S.S.U.) at 100 deg. F.	38
Flash	150 deg. F. minimum
Conradson carbon residue (maximum)	0.05 per cent
Acidity and alkalinity	Desired neutral
90 per cent distillation end point	Hold to Navy specifications
Water and sediment (maximum)	0.1 per cent
Ash (maximum)	0.02 per cent
Sulphur (maximum)	0.5 per cent
Centane number (minimum)	0.50

In switching service the four-cycle Diesel engine has given a good account of itself. This type of Diesel engine is being operated continuously for two years between removal of cylinder heads, piston assemblies, etc., for general inspection and repairs. An indication of the condition of these engines, after two years continuous service, is shown in the illustrations. All piston rings were free, wear of parts reasonable, carbon accumulation light and fluffy.

All of the present road locomotives are powered with two-cycle Diesel engines. Since these locomotives are operated under a load factor of about 60 per cent, more trouble is experienced with the Diesel engines. In fact, the Diesel engine maintenance expense comprises about 56 per cent of the total locomotive repair costs.

The use of good air filters and oil filters has increased lubricating oil drain periods from 5,000 miles to 100,000 miles of service for road locomotives. In switching service, crankcase lubricating oil is changed every three to six months of service. The specifications for lubricating oils and fuels used are given in Tables IV and V.

One of the illustrations shows a piston assembly from a two-cycle Diesel engine used in high speed passenger service after 100,000 miles of service. This piston assembly was found to be in good condition for further service.



This photograph shows the condition of the pistons and rings — The rings were free and the grooves clean. The oil holes in the pistons and the oil grooves in the rings are open — No wear was indicated on the pistons or piston pin assemblies

Cylinder liners that were worn .050 to .060 in. in about 60,000 miles are now removed when worn .020 in. after 325,000 miles of service and are reconditioned for reapplication. Cylinder heads are reconditioned every 100,000 miles and heads are repaired or reconditioned by welding.

Piston design has been improved. At the present time, the drop-forged aluminum piston with greatly increased ring land width is giving the most dependable service. Piston assemblies are removed for inspection every 100,000 miles and the service mileage received from pistons removed from road locomotives to date is 220,000 miles. This mileage will be greatly increased as new-type pistons replace the older design.

(*Continued on page 149*)

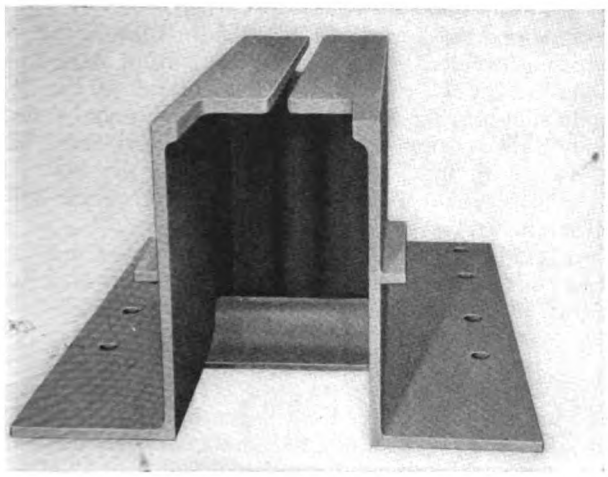
Table VI—Diesel Engines Now in Service on the Atchison, Topeka & Santa Fe

Manufacturer and type Diesel	Horsepower	Cycle	Number of cylinders	Arrangement	Bore and stroke, in	R.p.m.	Piston speed, ft. per min.	Weight of engine, lb. per hp.	Scavenging system	Injection system	Compression pressure, lb. per sq. in.	Combustion pressure, lb. per sq. in.	Mean effec. pressure, lb. per sq. in.	Number of engines in service
EMC 201-A	600	2	6	Line	8×10	750	1,250	21.9	Roots blower	Unit injectors	650	850	79.0	4
EMC 201-A	900	2	12	Vee	8×10	750	1,250	20.0	Roots blower	Unit injectors	650	850	79.0	29
EMC 567	1,000	2	12	Vee	8½×10	800	1,333	23.5	Roots blower	Unit injectors	600	1,250	73.0	17
Alco	600	4	6	Line	12½×13	700	1,518	58.4	None	Indiv. pumps	529	750	78.0	3
Alco	1,000	4	6	Line	12½×13	740	1,600	42.2	Buchi super charger	Indiv. pumps	480	750	110.0	12
De La Vergne Model VO..	660	4	6	Line	12½×15½	600	1,550	31.2	None	Indiv. pumps	450	650	76.3	1
De La Vergne Model VO..	1,000	4	8	Line	12¾×15½	625	1,604	34.0	None	Indiv. pumps	450	650	80.2	5

Northern Pacific Hoppers

THE American Car and Foundry Company has recently completed and delivered to the Northern Pacific an order of 200 fifty-ton hopper cars having a load limit of 128,000 lb. and a light weight of 41,000 lb. The cars follow the conventional riveted hopper car design with the exception of the body bolster and welded bolster center filler and embrace the use of open-hearth carbon steel. While the car has a stenciled capacity of 100,000 lb., a load of 128,000 lb. can be handled without exceeding the capacity of the four 5½-in. by 10-in. axles. The revenue load is 75.8 per cent of the maximum load on rails and the ratio of pay load to tare weight is 3.12 to 1. The cars were built at the builder's Huntington, W. Va. plant.

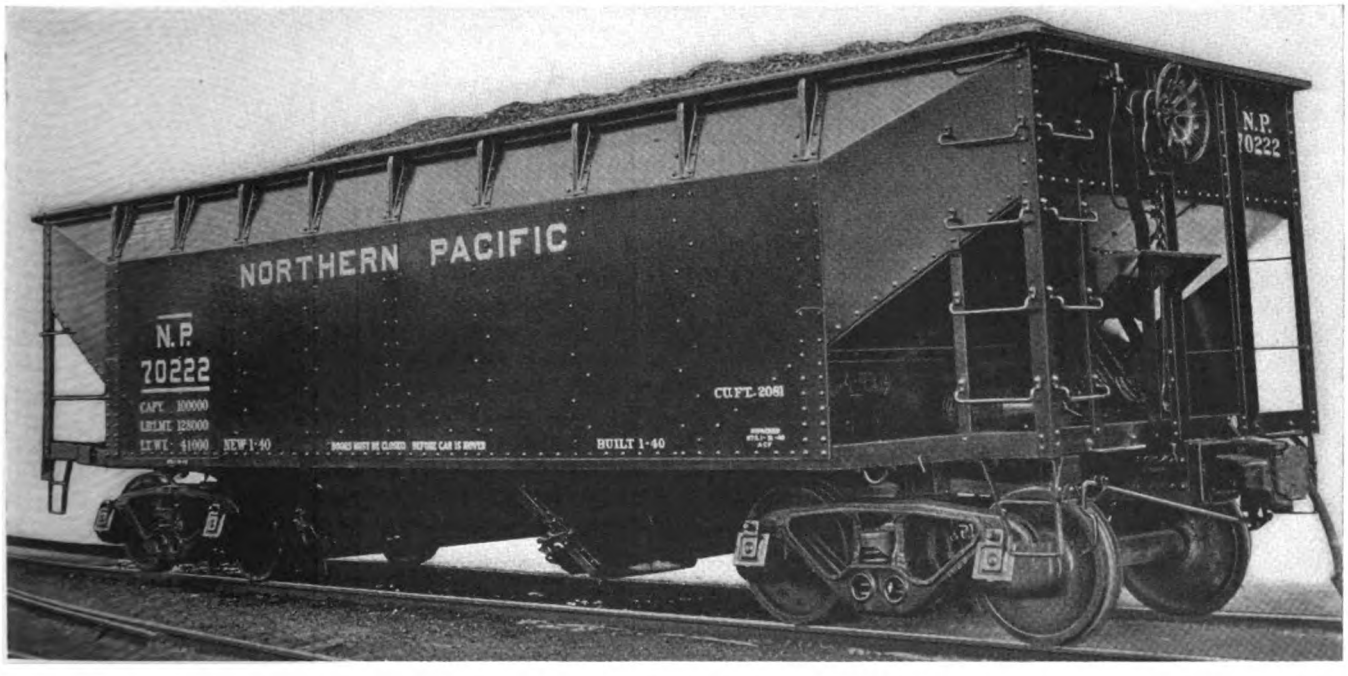
Special attention to the design of the car as a whole with respect to weight reduction results in 75.8 per cent ratio of lightweight to total loaded weight



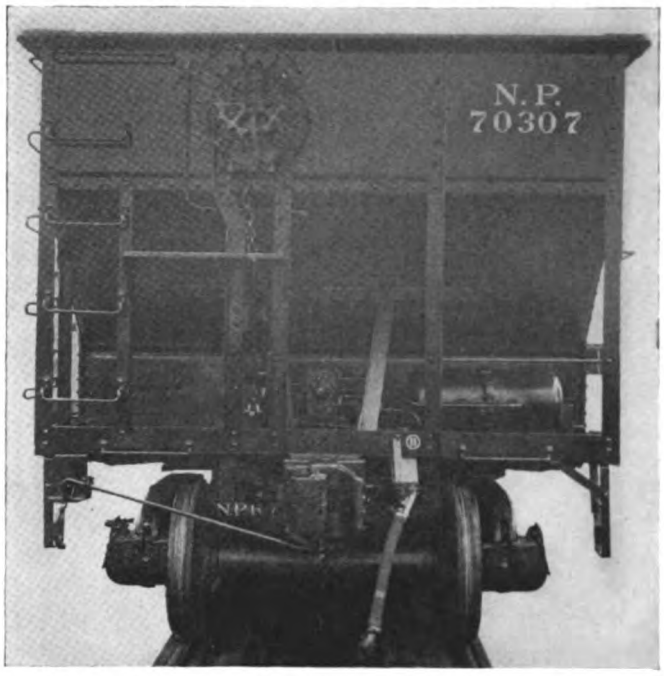
The bolster filler, consisting primarily of two A.A.R. Z sections, embodies the center pin guide and is secured to the center sills in an inverted position

Underframe Construction

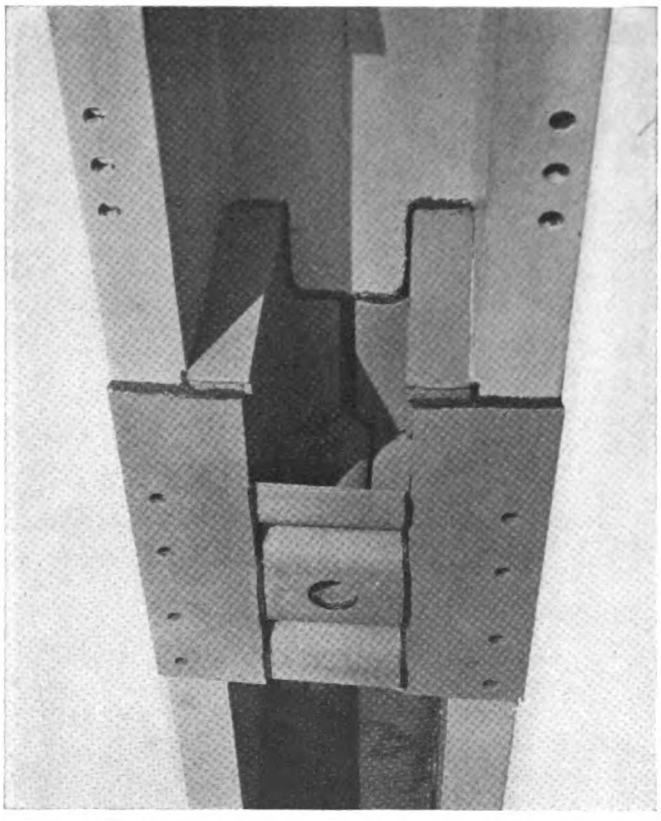
The center sills of this car consist of two A. A. R. Z-sections weighing 41.2 lb. per ft., welded together along the top center line. The special feature of the underframe is a fabricated construction at the bolster location. The use of steel castings for the bolster center filler has been replaced by the arrangement shown in the illustrations. The main members of the bolster center filler are two A. A. R. 36.2 lb. Z-sections, 24⅞ in. long placed in a reversed position, that is, with the heavy flanges at the top. These are welded along the flanged edges to the underside of the top flanges of the center-sill sections. The thin lower flanges pass under the heavy lower flanges of the center-sill sections to which they are secured by welding as well as by the rivets through the center plate and the lower flanges of the center sills. The rear draft-gear stop is a bar of USS Cor-Ten steel 1¼ in. by 3 in. by 12⅝ in. welded to the webs of the car center sills and to the web of the Z-shaped main member of the bolster center filler. A stiffener for the rear stop is welded to the vertical web of the draftgear main member and to the stop at the approximate neutral axis of the



Northern Pacific 50-ton hopper car built by American Car and Foundry Company



The end of the car—The I-beam bolster above the sills is seen under the slope sheet



A section of the center sill at the bolster showing the bolster filler construction

section. The bolster center filler design has been protected by patent application.

The center-pin guide is formed of two ⅜-in. steel plates shaped at their inner ends to form a pocket for the center pin and welded at their outer ends, full depth, to the vertical web of the main member of the bolster center filler. Over the center plate, between the webs of the main members of the center filler, there is a ⅜-in. ribbed plate welded to the main members for stiffness. Pressed diagonal braces of 5/16-in. material are used between the bolster and the end corners of the car. The body bolster, between the top of the center sill and the bottom of the slope sheet consists of a 21-in. by 8¼-in. by 59-lb. I beam with the upper flange bent to fit against the 30-deg. slope of the slope sheet. The upper flange is riveted to the floor sheets and the lower flange is welded to the top of the center sill. The outer end of the body bolster is riveted to the side structure through 3½-in. by 3-in. by ⅜-in. angles. A 6-in. by 4-in. by ⅜-in. angle is riveted to the web of each center-sill section and to the lower flange of the bolster I beam. The inner ends of the diagonal brace are also riveted to this angle. The body bolster is further reinforced toward the center of the car by a ¼-in. flanged plate, welded to the vertical web of the body bolster and to the top of the center-sill sections. The top flanges of this plate are riveted to the slope sheets.

The body side bearing is made up of 7/16-in. plate, No. 11 gage shim and a ⅜-in. high carbon, heat treated wear plate supported by an 8-in. by 20.5-lb. I beam, the web of which is welded at the top to the bottom flange of the body bolster I beam and at the bottom to the 7/16-in. body side-bearing plate. The three plate members of the body side bearing are riveted to the horizontal flanges of two 3-in. by 3-in. by ¼-in. angles, the inside ends of which rest on the bottom flange of the center sill construction and are welded thereto. These angles serve as diagonals to stiffen the body side bearing construction. The construction of the bolster and underframe end are shown in the drawings.

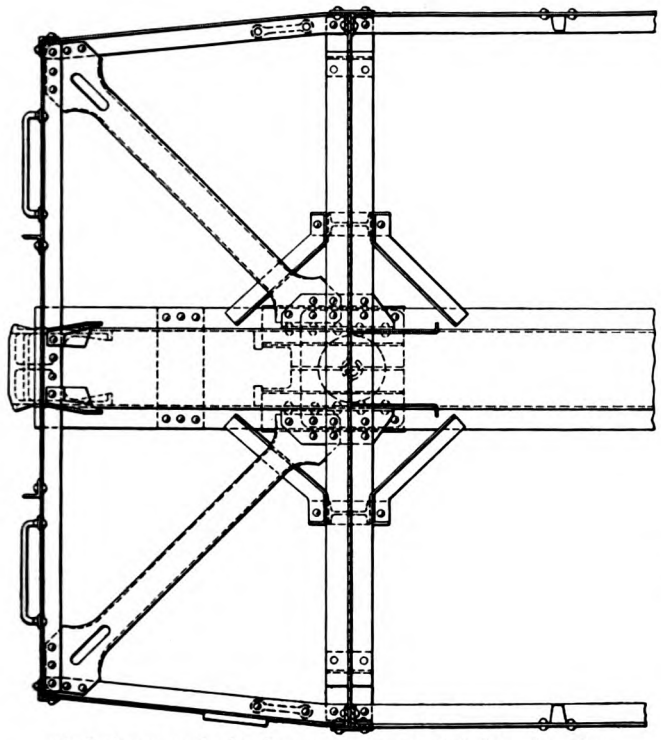
Body Construction

The side sills and end sills are 5-in. by 3½-in. by ⅜-in. angles running in one piece the full length of the car. The top, side, and end members consist of 5-in. by 3½-in. by 13.2-lb. bulb angles. The cross ridges are of ¼-in. plate with 3 1/16-in. 8.5-lb. Z-shaped bottom stiffeners and 3½-in. by 3½-in. by 5/16-in. side connection angles. The cross ridge and side-sheet braces are ¼-in. plate with 2½-in. by 3-in. by 6.1-lb. T-shaped stiffeners. The floor, or slope sheets, hoppers, car ends, and end side sheets are ¼-in. plate and the intermediate side sheets are 3/16-in. The floor sheets are flanged upward and riveted to the side sheets and are braced between the body bolster and end sill by 3½-in. by 3½-in. by 5/16-in. end angles. The side stakes are of the inside type pressed to U shape from 5/16-in. material. The car sides are sloped in at the top with outer side-stake fillers flush with the car sides. The hopper doors are flanged and pressed from 5/16-in. plate, are fitted to Enterprise hopper-door frames and equipped with Wine hopper-door fixtures.

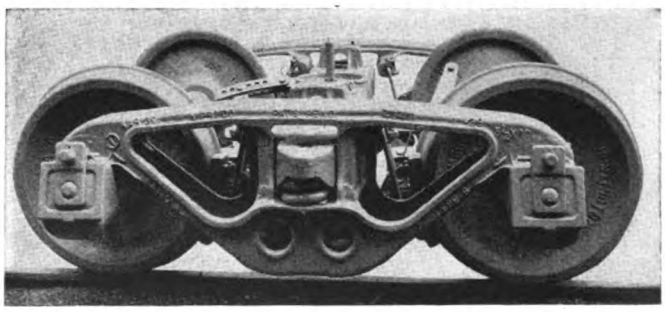
The trucks used on these cars are the National Type B

Principal Dimensions and Weights of Northern Pacific Hopper Cars

Length over strikers, ft.-in.	33-11¾
Length inside, ft.-in.	33- 0
Width inside, ft.-in.	10- 4
Width over-all, ft.-in.	10- 5
Height rail to top of side plate, ft.-in.	10- 5
Center to center of trucks, ft.-in.	24- 0
Truck wheel base, ft.-in.	5- 6
Capacity, lb.	100,000
Capacity, cu. ft.	2,081
Lightweight, lb.	41,000
Load limit, lb.	128,000
Ratio revenue to gross load, per cent	75.8
Ratio revenue to load to tare weight, per cent	3.12 to 1



Underframe end showing arrangement at bolster location

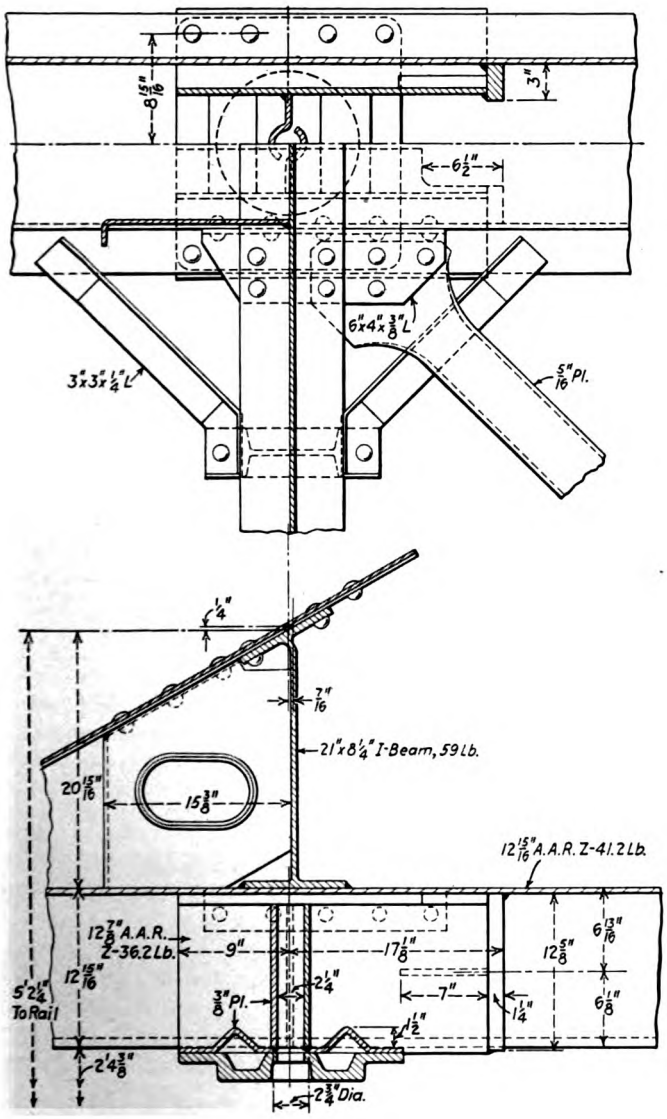


The four-wheel trucks have cast-steel side frames with boxes cast integral and wheels with treads ground after mounting on the axles

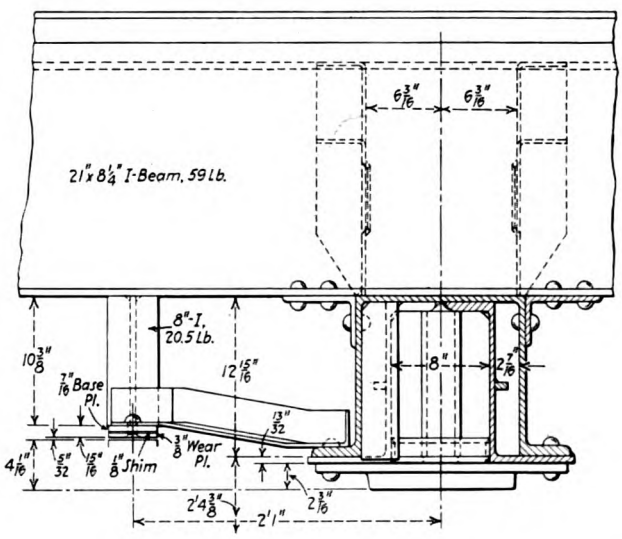
with the American Car and Foundry Company's chilled-iron single-plate wheels having treads ground after mounting on the axles. The trucks are constructed with cast-steel side frames having boxes cast integral, with cast-steel truck bolsters, Ajax brake beams, Schaefer brake-beam hangers, and Type E truck springs.

Draft Gear and Brakes

The cars are equipped with AB air-brake equipment furnished by Westinghouse and with Ajax hand brakes. The draft gear is the Edgewater friction type gear, with Buckeye Type E bottom-unlocking couplers, with cast-steel coupler yokes.



The arrangement of the welded fabricated steel center-sill filler, the 21-in. I-beam used between the top of the sills and the under side of the slope sheet, and the bracing are shown in these drawings



Equalizing the Flow of Air through

The Locomotive Grates

By S. H. Acker*

This paper presents the results of tests relating to the use of air restriction through the grates as means of controlling the draft and air distribution in a locomotive firebox

THE importance of the grates as a drafting device has been increasingly recognized, but even now there is a tendency to concentrate draft studies on the front end where the draft is created, rather than on the firebox where it is distributed, modified and used. A study of the results of tests conducted by the Northern Pacific on grates with restricted air openings and by the St. Louis-San Francisco on grates with non-uniform air openings will illustrate the importance of considering the grates when drafting locomotives. The grates developed by these tests have been standard equipment on the Northern Pacific for 14 years and on the St. Louis-San Francisco for 10 years. They have not only been proved by road test but they have withstood the trials of time.

Northern Pacific Tests

The Rosebud lignite coal fields in Montana cover large areas and the coal may be mined easily by the strip method. The mechanical department of the Northern Pacific obtained discouraging results from their first attempts to burn Rosebud lignite coal because it was so light that even with reduced tonnage in the train the fire would be pulled from the grates before the train could be moved to the main-line switch. Every conceivable adjustment was made to the standard drafting devices but still the fire could not be maintained. Finally, the air openings, through the grates, were restricted and a great improvement resulted immediately.

The successful burning of lignite coal by the Northern Pacific indicated that the use of grates as a drafting device, rather than as something necessary merely to sustain the coal while it is burned, would remove some of the restrictions on the quality of fuel required for locomotives. The Northern Pacific conducted a series of dynamometer-car tests to ascertain what results might be obtained by using the grates with restricted air openings, not only with lignite coal, but also with the bituminous coals which were then being burned on the locomotives of that road. The proximate analyses of the coal used in these tests is shown in Table I.

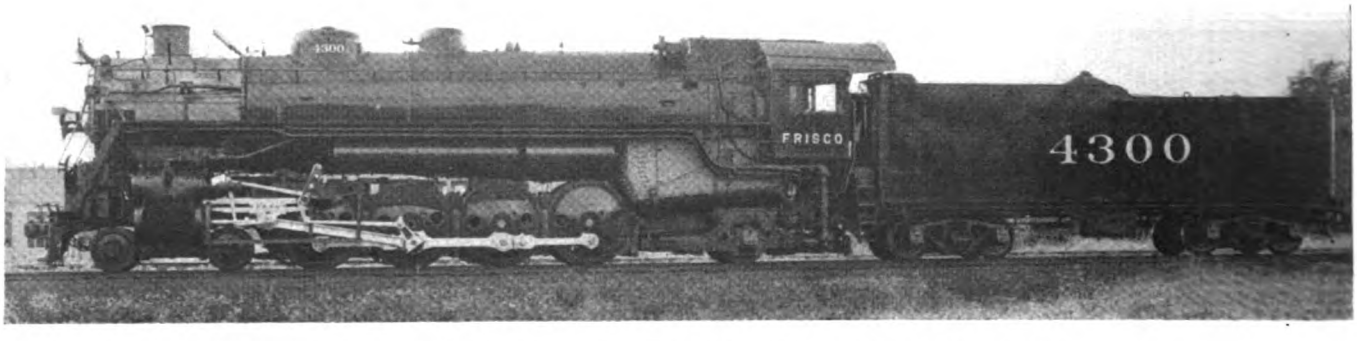
The results of the tests are shown in Table II. It should be noted that the boiler, furnace, and grate efficiencies do not include the heat of superheat which would increase the efficiency about five per cent. Since the heat of superheat is included in none of the calculations, the figures given are a true measure of the comparative value of the coals and grates tested. The use of boiler, furnace, and grate efficiency for a comparison of grate values is justified because the same boiler and furnace were used, the grates being the only variable.

The Rosebud lignite burned with practically the same efficiency on the ½-in. and ⅝-in. round-hole grates. As stated before, this lignite could not be burned at all on the old standard, ¾-in. slotted grates with 36 per cent air opening.

The difference of efficiencies with which Red Lodge coal burned on the two round-hole grates is also very small. Designating the boiler, furnace, and grate efficiency of the ½-in. round-hole grates (57.78 per cent) as 100, the rating of the ¾-in. slotted grates would be 94.0. This rating of the slotted grates with 36 per cent air opening as 94 per cent as efficient as the grates with 13.46 per cent air opening is decided proof that the Red Lodge coal burns more efficiently on grates with restricted air openings and this was more than substantiated by observations in regular service.

The average boiler, furnace, and grate efficiency produced by burning Roslyn coal on the ½-in. round-hole grates was 54.31 per cent and on the ¾-in. round-hole grates was 56.44 per cent. Subsequent dynamometer car tests showed that Roslyn coal burned with a slightly higher efficiency on the ⅝-in. round-hole grates as compared with the ½-in. round-hole grates and any further increase in the percentage of air opening resulted in a decrease in efficiency. This leads to the hypothesis that a coal with a high percentage of ash which is heavy enough to remain on the grates does not require the air openings through the grates to be restricted as much as

* Assistant professor of Mechanical Engineering, Vanderbilt University.



One of the St. Louis-San Francisco locomotives equipped with grates having 25-35 per cent air opening

Table I—Average Proximate Analyses of Coals

Coal	Type of grate	Moisture, after air drying per cent	Volatile and combustible, per cent	Fixed carbon, per cent	Ash, per cent	Sulphur, per cent	Heating value, B t.u., per lb.	
							Air dried	As fired
Rosebud	½-in. round-hole	8.33	35.14	46.23	10.31	0.58	10,435	8,396
Rosebud	⅝-in. round-hole	9.36	34.65	45.53	10.46	0.63	10,354	8,418
Red Lodge	½-in. round-hole	4.34	36.95	44.24	14.53	1.03	10,845	10,067
Red Lodge	⅝-in. round-hole	4.11	38.05	43.35	14.50	1.15	10,796	10,013
Red Lodge	¼-in. slotted	5.18	36.65	44.72	13.45	1.06	10,865	10,291
Roslyn	½-in. round-hole	1.42	37.60	42.63	18.35	0.37	11,628	11,325
Roslyn	⅝-in. round-hole	1.34	38.00	42.57	18.09	0.36	11,673	11,367
Roslyn	¼-in. slotted	1.16	37.98	43.39	17.48	0.41	11,801	11,401

a coal with a lower ash content. The accumulation of heavy ash on the grates furnishes a resistance to air flow which decreases the amount of resistance required in the grates.

Tests on the St. Louis-San Francisco

The possibility of advantageously restricting the air openings more in certain portions of the grates than in other positions as a means of improving firing conditions by equalizing the combustion throughout the firebox has been demonstrated by another series of experiments which were conducted on the St. Louis-San Francisco. The results of these experiments were published in the April, 1930, issue of the *Railway Mechanical Engineer* and are briefly summarized here.

Table II—Boiler, Furnace, and Grate Efficiency

Type of Grate	Air opening, per cent of grate area	Boiler, furnace, and grate efficiency, per cent		
		Rosebud	Red Lodge	Roslyn
½-in. round-hole	13.46	44.52	57.78	54.31
⅝-in. round-hole	15.07	43.93	56.91	56.44
¼-in. slotted	36.0	...	54.31	56.65

The mechanical department of the St. Louis-San Francisco was faced with the problem of successfully burning several different varieties of coals in the same locomotives. Extreme difficulty was sometimes encountered in maintaining a new fire in the rear portion of the firebox equipped with the old standard grates with 35 per cent air openings until the speed of the train had increased sufficiently to permit the cut-off to be shortened with the resulting decrease in the draft. To reduce the chances of having holes torn in fire, the fireman running out of certain terminals always built up "heels" in their fires although the "heeling" of the fire was not recommended. The use of the thickness of the fire bed as a means of equalizing combustion results in clinkers, banks, and generally poor firing conditions if carried to excess.

The tests definitely established the fact that the draft in the rear of the firebox was greater than that in the front and that the setting of the draft plate had little or no effect upon this ratio. The substitution of increased resistance to air flow through the rear grates in place of thicker heels was accordingly made to eliminate the need of "heeling" the fire. The air opening in the rear of the firebox was reduced to 25 per cent while the 35 per cent air opening through the front grates was retained. This arrangement of grates was made the standard practice in 1928, and is unchanged except for some further restriction through the rear dump grates.

Investigation of Draft Distribution in Locomotive Firebox at Vanderbilt University

Further verification of the naturally uneven distribution of air to the front and rear of the firebox has been made at Vanderbilt University. The apparatus used was a slight modification of a device, described by H. L. Parr of Colorado University in Mechanical Engineering of June, 1937. He calls this device a "fluid-flow analyzer." It is used to show the lines of air flow past scale models to demonstrate the effect of streamlining, and has been found accurately to duplicate results obtained in wind tunnels with full scale models. As constructed, it does not measure actual velocities excepting as they can be followed with the eye.

Fig. 1 shows the essential features of the fluid flow analyzer. It is a wooden box on top of which two pieces of plate glass are spaced ¼ in. apart. An exhaust fan operated by an electric motor pulls air between these pieces of glass past the cross section models as shown by the photographs. A trough containing liquid titanium tetrachloride is located near the air inlet, as shown. Slots are cut at equal intervals along the trough so that the streamers of "smoke" are carried into the air streams as they move past the trough.

A model of a cross section of a locomotive firebox was cut from rubber and placed between the sheets of plate glass. The streamers of titanium tetrachloride delineated the paths of travel of the air through the firebox model. Photographs were taken illustrating several different conditions in the firebox.

Fig. 2 shows the paths of the gases through a firebox not equipped with an arch. The velocities toward the front of the firebox were very much greater than those in the rear. This was much more pronounced than can be shown by a photograph showing the moving streams

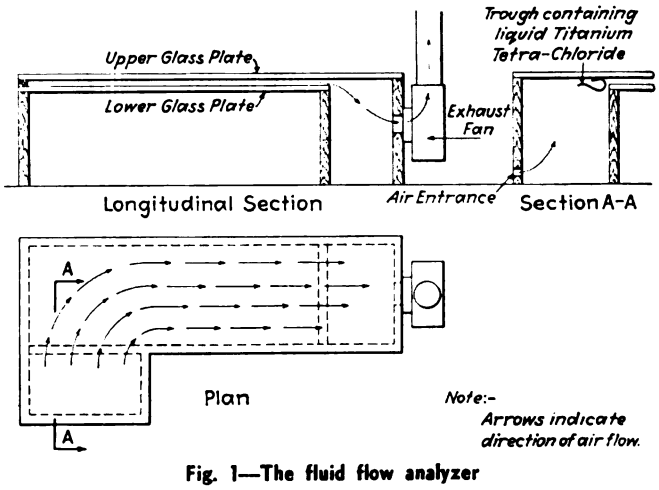


Fig. 1—The fluid flow analyzer

as being static. The disparity in the volumes taken in through the front and rear of the firebox is indicated, however, by the much larger area covered by the streams from the front of the firebox than by those from the rear after the gas has approached the tubes and the velocities of the various streams become more uniform. The gas from the seven rear slots fills only the top four tubes, while the gas passing by the front four slots occupy the bottom four tubes. This is a visual demonstration of the reason for the fire being pulled in the front of the firebox when the locomotive has no arch. The fuel under these conditions would burn much more rapidly at the front of the firebox; and the firemen were fortunate that, before arches were common, fireboxes were small and the firing distance to the front of the firebox was short.

The complete failure of the various streams to mix demonstrated one reason for the superiority of combustion on arch-equipped locomotives. Without the arch there is practically no mixing of the excess combustible volatiles generated in one portion of the firebox with the excess oxygen in the stratas from the thin portions of the fire. Even with a combustion chamber, such as that in the model, the travel of a large percentage of the gases is too short for complete combustion of volatiles. The arch also improves firing conditions for other reasons, such as hastening the ignition of the fresh fuel, increasing combustion temperatures, besides mixing the various stratas from the fuel bed to some extent.

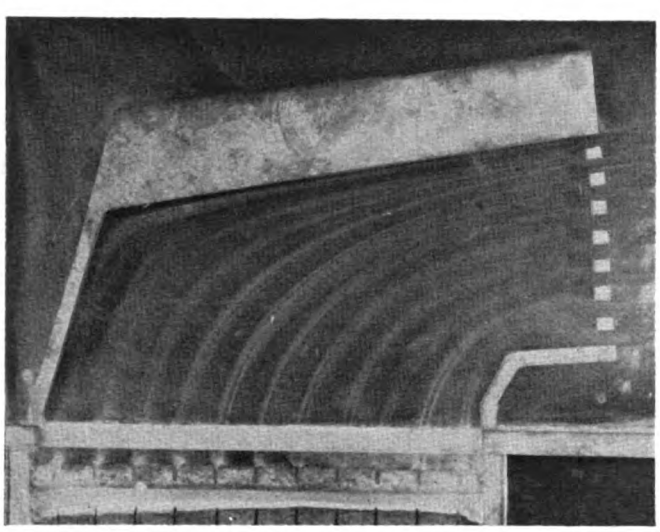


Fig. 2—The paths of the gases through a firebox without an arch

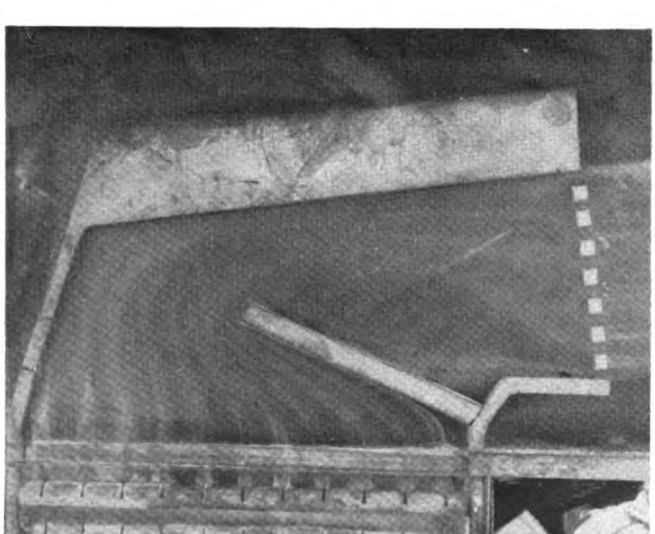


Fig. 3—The effect of the arch on the flow of gases

Fig. 3 was taken with a closed arch and with no restriction through the grates other than that introduced by the constriction of the space between the trough containing the titanium tetrachloride and the framework of the box. In this picture, as well as others taken under these conditions, the peculiar crossing of the lines of flow from the front of the firebox and those from the rear might be noted. This is evidence of the better mixing of gases when an arch is in the firebox. It is apparent that the streams of gas from the forward end of the firebox tend to increase the radius of the sharp bend around the arch and are thrown to the outside across the other streams. As was stated before, actual observance of the apparatus while in operation is much more striking than can be seen in photographs which do not show actual velocities. The streams from the rear of the firebox travel with much greater velocity than those from the front. In fact, even the photograph shows that the rate of travel and the quantities of gases in the two streams under the toe of the arch are so small that these two streams lose their identity before they traverse the length of the arch. Compared to the streams from the rear of the firebox, they scarcely seemed to move. It is apparent that a relatively small quantity of coal would be burned in this location as compared with the quantity which would be burned on an equal area of grate in the rear of the firebox. The corroboration of the draft readings obtained on the Frisco tests, showing the air flow through the rear grates to be greater than that through the front when the resistance to flow is uniform, is evident.

Fig. 4 shows the effect of opening the arch. It results in increasing the draft in the front of the firebox, tending to equalize the rate of air flow over the firebox. The mixing of the front and back streams at the throat of the arch may again be seen. The extremely short path of the gases from the surface of the fuel bed at the front of the firebox to the tubes is, however, apparent; and any slight increase in evaporative efficiency through equalizing the rate of combustion of the different portions of the grate surface will be offset by chilling a large part of the volatile gases and oxygen below the temperature of combustion before the burning is completed. One of the most apparent advantages obtained by the installation of an arch is the lengthening of the path of travel of the burning gases before they strike the relatively cold tubes. Opening the toe of the arch and short circuiting the gases from the front of the firebox to avoid excessive draft in the rear of the firebox is not desirable if the same result can be accomplished by better means. Of all the locations in the firebox, the front needs to have the travel of its gases increased most because it is the closest to the tubes. With the open arch there is no opportunity whatsoever for mixing the gases from the front and rear of the firebox, so that the rich gases may obtain some of the excess oxygen from the lean. Of course, even with the closed arch there is marked stratafication of the firebox gases, but at least there is some mixing.

Fig. 5 shows the effect of opening the firedoor. The chief result would appear to be that a strata of cold air travels along the crown sheet, partly insulating the firebox heating surface from heat transfer by convection. It might be remarked that the opening of the door when starting the train relieves the vacuum peaks to some extent, thereby preventing some of the severity of the

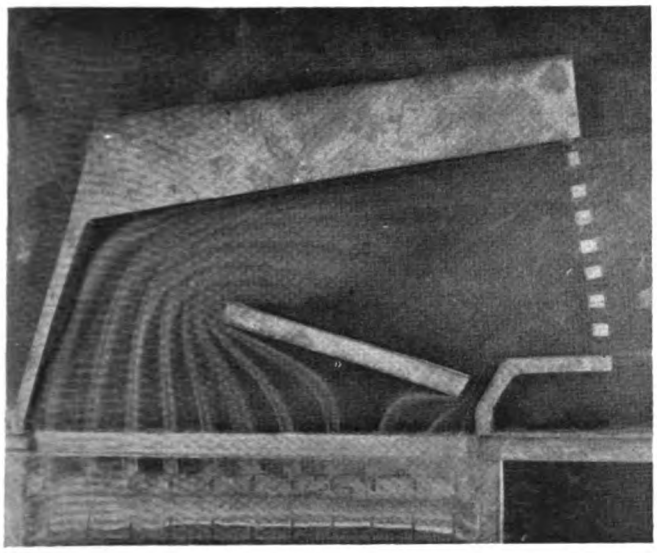


Fig. 4—There is no mixing of the gases from the front and rear of the firebox when the toe of the arch is open

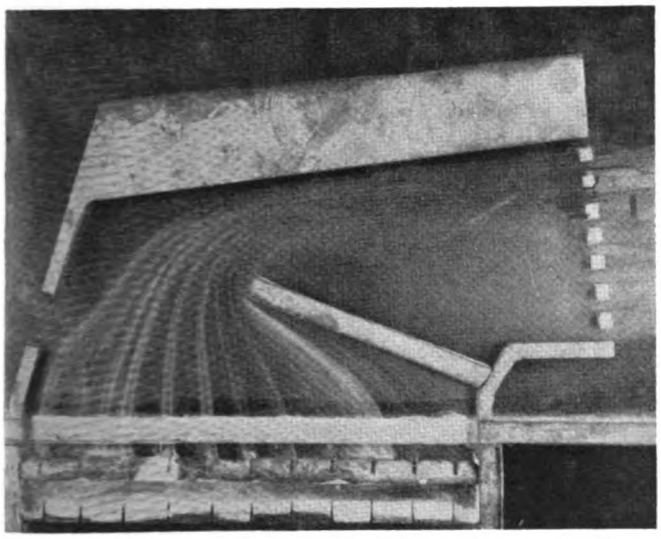


Fig. 5—The effect of opening the firedoor on the flow of gases

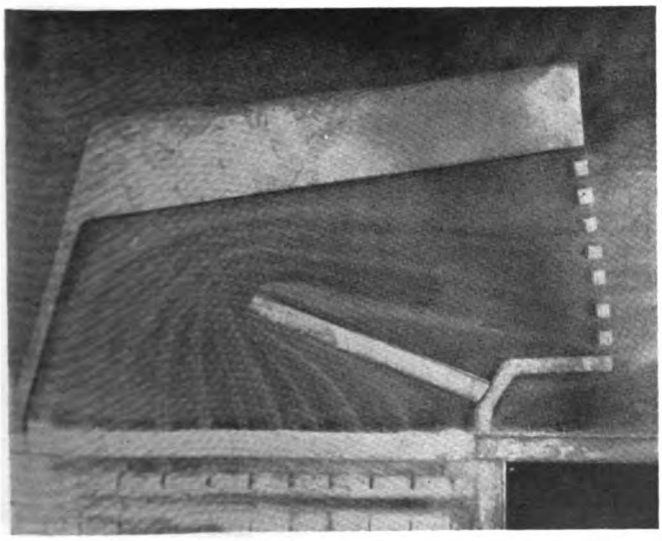


Fig. 6—The flow of gases from the front and rear of the firebox is equalized by introducing a variable resistance in the grates

tearing of the fire. This method of protecting the fire is occasionally used by some firemen. The photograph again shows the two front streams to be relatively quiescent.

Fig. 6 shows the effect of introducing a variable resistance in the grates. A strip of rubber was placed between the upper and lower sheets of glass in the position usually occupied by the grates. The strip was planed off so that the restriction in the rear of the grates back of the arch was 50 per cent and under the arch the restriction tapered from 50 per cent at the rear of the arch to 25 per cent at the toe. That is, the air opening was uniformly increased from 50 per cent at the back of the arch to 75 per cent at the front. Actual observation showed the various streams of air moving at approximately the same speed under these conditions. The picture shows that the air streams from the front of the firebox are more definite than they were before the restrictions were introduced, and their courses followed along the arch. The area occupied by the streams from the front half of the grates and the area occupied by the streams from the rear half of the grates is approximately equal when they converge back of the arch. This demonstrates the value of restricting the air opening through the rear grates to a greater extent than that through the front grates.

Conclusions

There is no doubt but that the present tendency in locomotive design is to increase the grate area, allowing slower and more orderly combustion of the coal. Some of the benefits of this increased area may be lost if the combustion is not properly controlled. The thin fires of relatively small fuel particles which have come with the stoker require a gentler treatment than the thick lump coals of the hand-fired era. Yet the locomotives are worked harder and the demands on the fire are greater. The resistance to air flow through the grate should no longer be considered an undesirable consequence of supporting the firebed, but should be used to control the rate of combustion in the various portions of the fire, and to modify the blasting action of the exhaust at long cut-off.

The adjustment of the draft plate does not throw the higher draft from one portion of the firebox to another. It merely levels off the peaks of draft resulting from the intermittent exhausts, and as such might be required to supplement the air restriction through the grates. The Northern Pacific, however, has dispensed with draft plates entirely upon some of their locomotives, and a great many roads could profitably relieve the constriction under the draft plate, replacing it with a much less severe restriction through the grates.

Restricting the grates more in the rear of the firebox than in the front tends to equalize the combustion rates throughout the firebox. An ideal application would be one where the resistance through the grates plus the resistance overcome by each stream of gas as it follows its path around the arch and through the tubes would be equal for every portion of the firebox. The difficulty of exactly achieving this result is not justification for failing to equalize the air flow to some extent.

The use of restricted air openings through the grates does not necessarily mean a reduction in the diameter of the nozzle tip. In fact, the area of the nozzle might be increased in some cases, with a consequent reduction of back pressure in the cylinders. If the air is admitted evenly throughout the grate area, less excess air will be needed, requiring the movement of a smaller volume of gases. Banks and heels may be done away with in some

(*Continued on page 148*)

A Proposed

Combustion-Turbine Locomotive*

Report of a committee of the Railway Fuel and Traveling Engineers' Association sets forth specifications for a combustion turbine combined with hydraulic torque converter and hydraulic coupling, and worm-gear drive

More than ten years ago the Steam Turbine and Condensing Locomotive Committee recommended and proposed a design for a type of motive power which would have a uniform continuous torque or flow of power to the driving axles and eliminate vibration. The motive power proposed was a steam turbine used almost exclusively in large power generating plants. A design of such locomotive with this kind of power has recently been built and is undergoing further development.

A new method of power generation has been developed during the last five or six years in that a practical method of utilizing an old heat cycle was discovered in connection with work on superchargers for internal-combustion engines. This is the gas turbine, or more correctly a combustion turbine, as it is operated by the products of combustion. Several plants using the combustion turbine are operating in this and foreign countries and the horsepower developed by such plants runs into the thousands.

This type of combustion turbine has been developed by Brown, Boveri & Company, Ltd., Baden, Switzerland. The engineering director of this company, Dr. Adolph Meyer, read a paper at an Oil and Gas Power Division session of The American Society of Mechanical Engineers, at the semi-annual meeting in San Francisco in July, 1939, on The Combustion Gas Turbine, Its Present Stage of Development and Prospects for the Near Future.† In it the author states that Brown, Boveri & Company has an order from the Swiss Federal Railways for a 2,200-hp. combustion-turbine locomotive and this locomotive is under construction.

The very promising reports from combustion turbines in service and the engineering possibilities of this development so interested the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., that this company has made not only a thorough check of this design and construction, but has actually tooled up and built several of these combustion turbines in sizes from 3,000 to 6,000 hp.; these are in service in several of the large oil refinery plants. The Allis-Chalmers Manufacturing Company has taken out a license to manufacture the combustion turbine in this country. Furthermore, it has spent a very large amount of time, energy and money during the last two years developing designs for the application of the combustion turbine to a locomotive. These designs have been developed for application of the combustion turbine with electric transmission and also with mechanical transmission in order to have complete information as to weight, cost, efficiency, and general practicability of the two types of transmission.

In his paper referred to above, Dr. Meyer said: "An interesting application of the gas turbine is the gas-turbine locomotive. It is well known that the efficiency of a steam locomotive is only of the order of 8-12 per cent, the latter figure allowing for all improvements made in the course of the last few years. The gas turbine with its coupling efficiency of 17 to 20 per cent finds here a promising field of application, since it should be possible to obtain an efficiency of approximately 15 per cent with mechanical transmission, or approximately 14 per cent with electrical transmission. These efficiencies do not naturally allow for competition with the Diesel engine, but the difference between the fuel consumptions of the two machines is in many cases fully compensated for by the difference in the costs of Diesel oil and fuel oil. Moreover, in many cases the possibility of getting more power from a given size of locomotive is of greater importance than the efficiency. Since about twice the output of a Diesel-powered locomotive can be installed in a corresponding combustion-turbine locomotive the latter, in many cases, deserves due consideration from this point of view. Another advantage, compared with steam locomotives, is the fact that the gas-turbine locomotive needs no water, thus doing away with cleaning of boilers and interruptions of service resulting therefrom.

"In the case of electrical transmission, only the gas-turbine part is new, the generators, motors, and switchgear being adopted from the Diesel-electric locomotive without modification. The gas turbine which drives the generator through gearing can always be operated at the most suitable speed for the compressor (this is also true for the mechanical transmission) so that the engine gives a high efficiency at all speeds and loads. Such a locomotive is, of course, heavier and more expensive than one with mechanical transmissions, but since it will be necessary to provide, in addition to the forward turbines, reverse turbines or corresponding reversing gears, difficulties may have to be overcome, especially in case of high outputs with the mechanical transmission."

The statements in the above quotation indicate a preference for the electric transmission for one reason, that the designs are already developed and the equipment can be standardized with that in service for Diesel locomotives, while the mechanical transmission would require development.

After full consideration of all factors in connection with the two types of transmission, it was decided to make a proposal for the installation of the mechanical transmission to a combustion-turbine locomotive and, in order to compare it with existing steam and Diesel-electric-powered locomotives handling modern high-speed passenger trains, it was decided to make such proposal to cover a locomotive of 5,000-hp. capacity. It was decided to use a two-speed hydraulic transmission in duplicate, one for forward, the other for reverse motion.

* An abstract of a report of the Turbine and Condensing Locomotive Committee presented before the meeting of the Railway Fuel and Traveling Engineers' Association held at Chicago, October 17, 18 and 19, 1939. L. P. Michael, chief mechanical engineer, Chicago & North Western, is chairman of the committee.

† See Mechanical Engineering (A. S. M. E.) for September, 1939.

Combustion Turbine

The cycle of operation is shown in the drawing and includes a heat exchanger, not shown on the main construction diagram. The cycle of operation can probably be best described by referring to the diagram in the upper left corner of the drawing.

To place the equipment in operation, first switch on the starting motor which, through an extension shaft, turns the axial compressor, turbine and generator. The compressor draws in air at an assumed temperature of 68 deg. and at atmospheric pressure and compresses it to about 45 lb. gage, and in so doing heats it to about 365 deg. F. when up to speed. This heated air then passes on to the burner and mixes with fuel oil sprayed into the space around the ignition point. An electric ignition system is to be provided. Combustion then takes place in the space at the left of the ignition point inside the burner jacket and continues on into the combustion chamber.

Inside the burner jacket the combustion temperature may rise to 3,300-3,600 deg. F., but these gases of combustion are cooled by mixing with the air at 365 deg. F. moving leftward through the annular space around the burner jacket into the combustion chamber. The gases of combustion are thus cooled to about 1,000 deg. F. before passing on to the gas turbine and are exhausted through the turbine blading to the atmosphere at about 600 deg. F., or they may be passed through a heat exchanger as indicated in the combustion cycle. In round figures, when using a gas turbine of 10,400 hp. and operating the equipment as referred to above with turbine and compressor efficiencies of about 84 and 83 per cent, respectfully, a net of about 2,500 hp. can be developed after deducting 7,900 hp. required to drive the compressor. The thermal efficiency of this cycle is shown approximately in the diagram. The speeds of the compressor and turbine are about 4,000 r. p. m.

Since the temperature and pressure of the gases of combustion to the turbine are about 1,000 deg. F. and 45 lb. gage, respectively, when no heat exchanger is used, the approximate efficiency will be found on curve *1* immediately above the compression ratio *3*. It is about 15 per cent. With combustion air preheaters (heat exchangers) using the exhaust gases from the turbine to preheat this air, the efficiency of the cycle may be increased considerably, depending on the amount of preheating surface and the final temperature of the air to the burner. This is shown on curves *2, 3,* and *4,* curve *4* indicating an efficiency of about 25 per cent maximum.

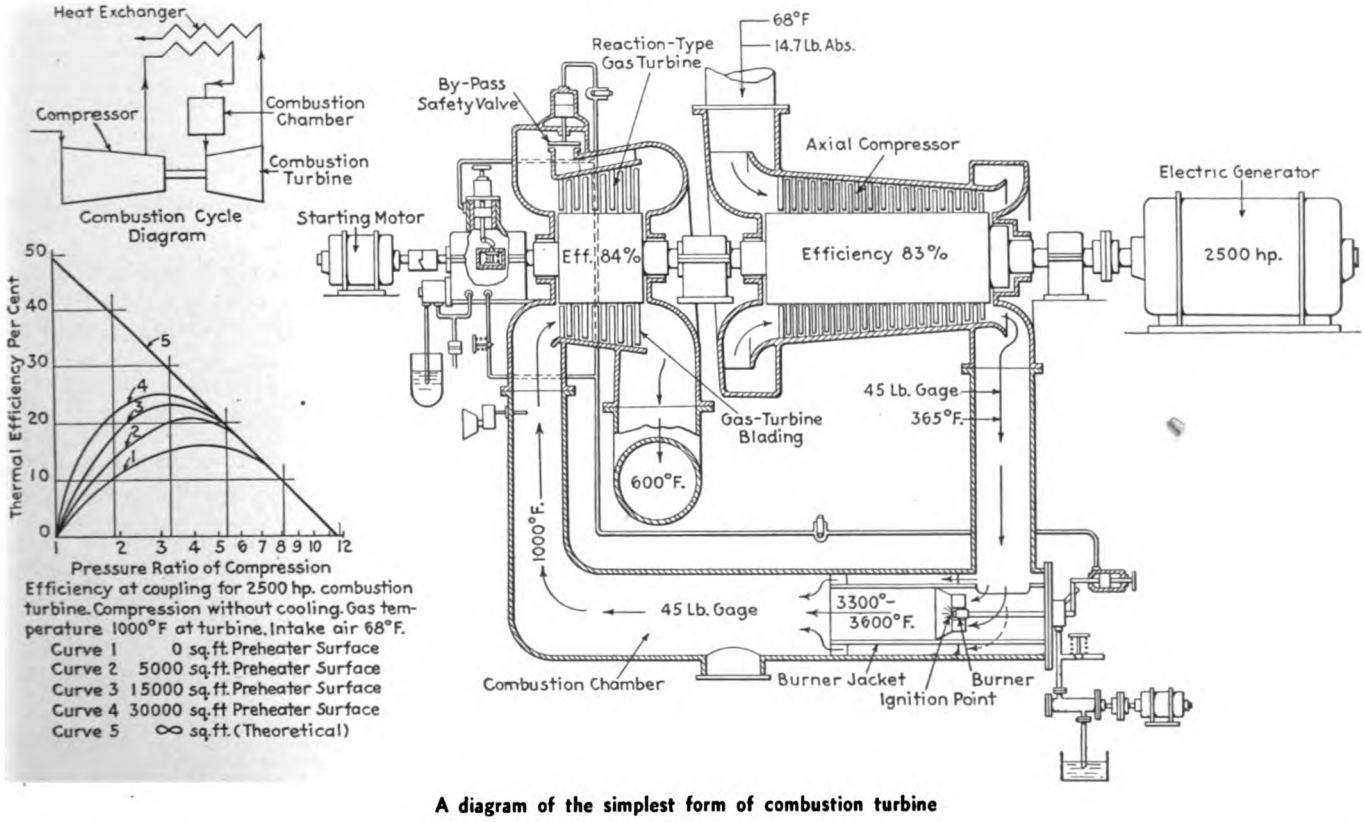
Dr. Meyer, in his paper referred to above, states that with combustion gases to the turbines at 1,200 deg. F. and suitable preheaters and reheaters between two turbine stages, an efficiency of about 33 per cent can be obtained. This is approximately the same as claimed for a Diesel engine. In the closing paragraphs of his paper Dr. Meyer says:

"The prospects of the gas turbine, if it is possible—as the author believes it is—to raise the temperature in the near future to 1,200 deg. F., can be readily appreciated. This belief is based upon the experience obtained with a number of Diesel-engine supercharging units which have been in operation for a considerable time at temperatures approaching this value, and, on tests with relatively rudimentary cooling arrangements, which show that temperatures around 1,800 deg. F. are in the realm of possibility."

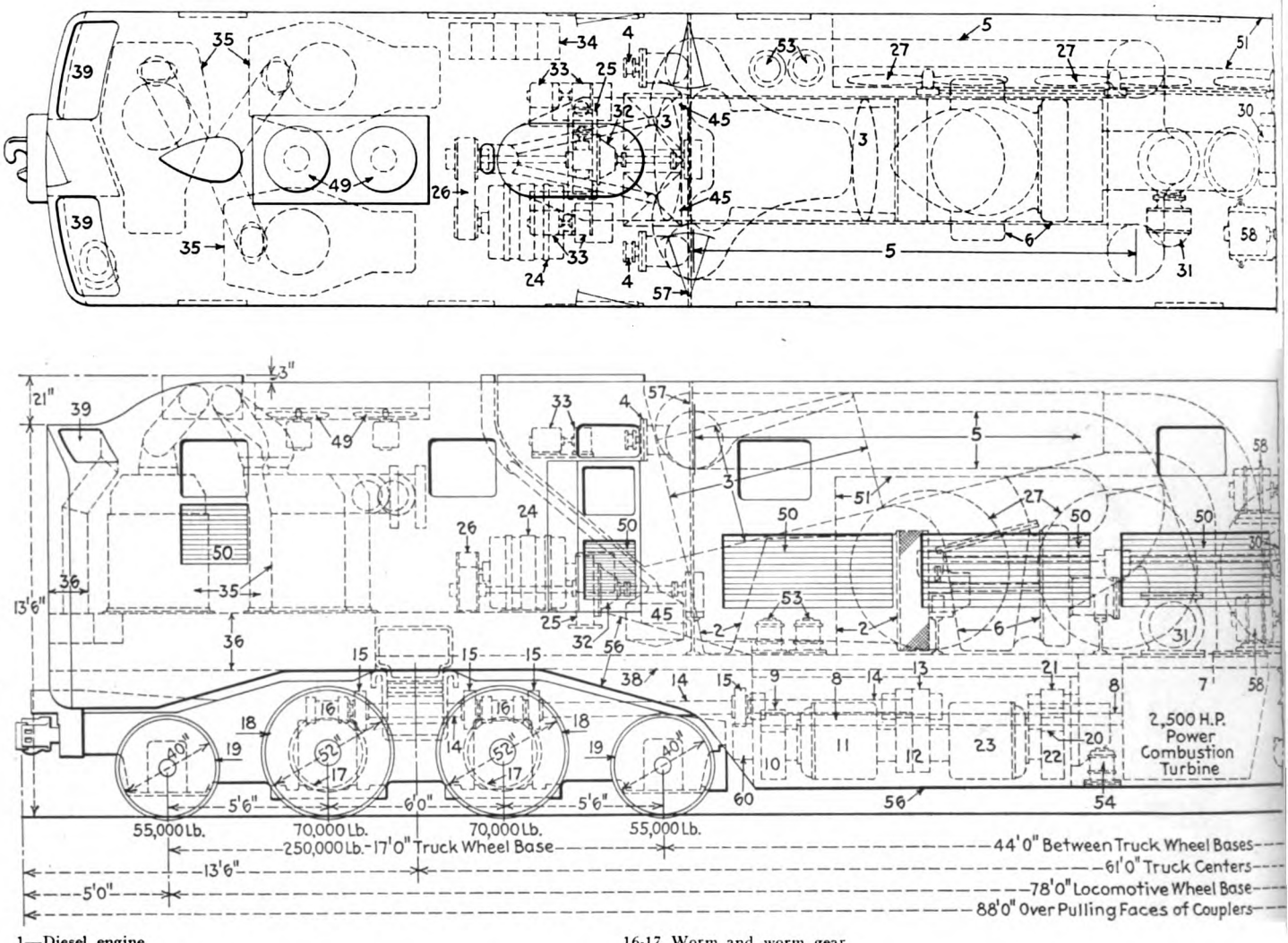
Hydraulic Torque Converter and Coupling

The hydraulic torque converter and coupling were both originated by Dr. Foettinger of Germany. The coupling was particularly developed in England by Harold Sinclair, while the combination of torque converter and coupling was perfected in Germany by the J. M. Voith Engineering Works. This equipment is now being built under license or handled by the American Blower Company, Detroit, Mich.

In the proposed designs a combined hydraulic converter and hydraulic coupling are enclosed in a common



A diagram of the simplest form of combustion turbine



1—Diesel engine
2—Combustion air compressor
3—Combustion air preheater
4—Oil burner
5—Combustion chamber
6—Main combustion turbine
7—Power combustion turbine
8—Driving shaft from turbine
9—Driving-shaft pinion, forward motion
10—Driving gear, forward motion
11—Combined hydraulic converter and hydraulic coupling, forward motion
12-13—Main power transmission gears
14—Tubular power transmission shaft (one to each driving axle)
15—Universal joints
16-17 Worm and worm gear
18—Driving wheels
19—Truck wheels
20—Driving-shaft pinion, reverse motion
21—Reverse-motion idler gear
22—Driving gear, reverse motion
23—Combined hydraulic converter and hydraulic coupling, reverse motion
24—Electric generator and starting motor
25—Auxiliary combustion-turbine power for electric generator
26—V-belt power transmission
27—Radiator fans, combustion-turbine driven
28—Radiator fan, motor driven
29—Radiator-fan combustion turbine
30—Radiator-fan motor

A proposed 5,000-hp. combustion-turbine locomotive with hydraulic transmission and

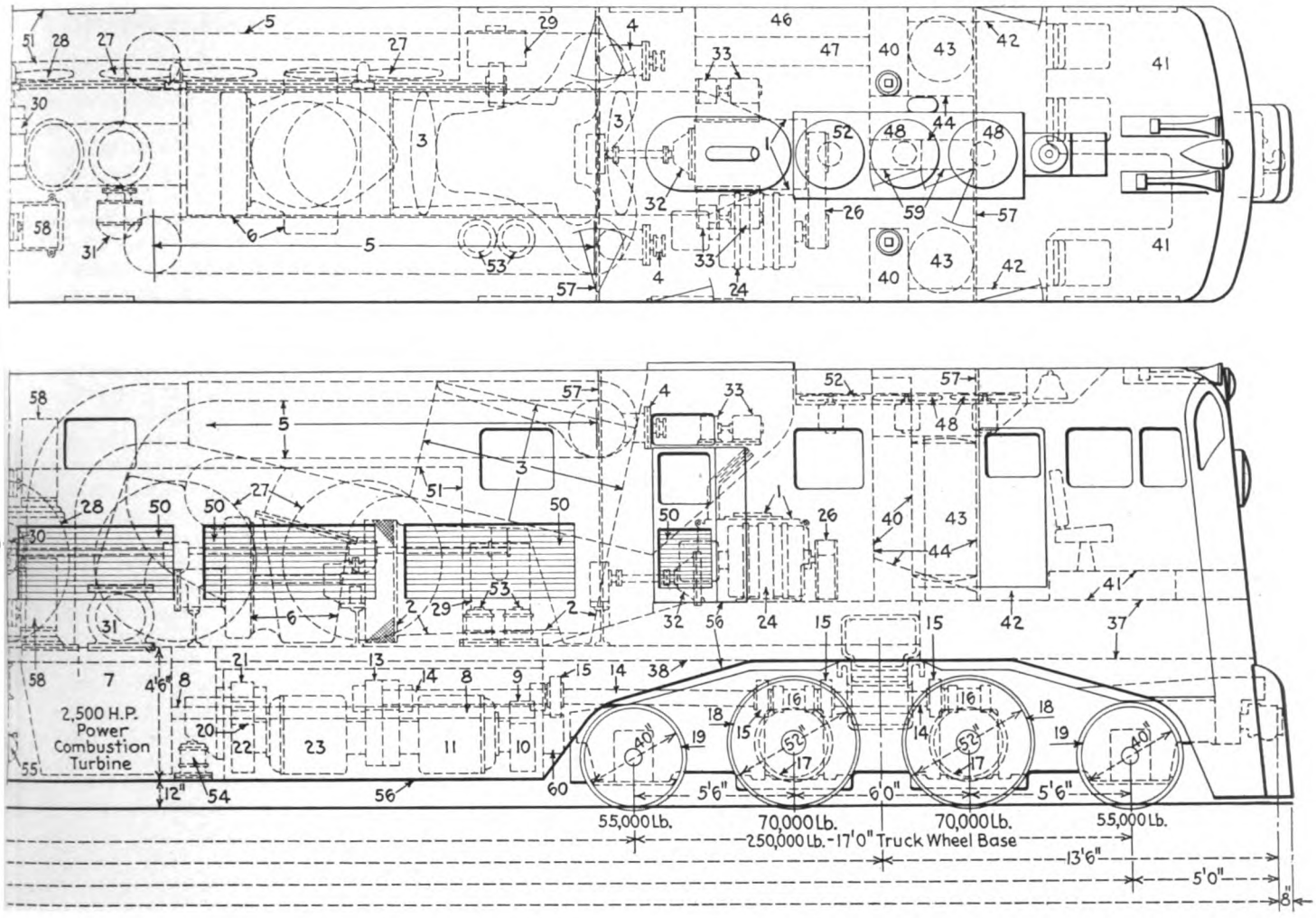
housing in such a manner that the converter can be used for starting and lower speeds and the coupling for continuous higher speeds. The driving shaft is keyed directly to the impellers or driving members for both the converter and coupling. The runners, or driven members of both the converter and coupling are keyed directly to the driven shaft.

The torque converter, as the name implies, is used to convert or increase the torque of the driven shaft to nearly double that of the driving shaft, but with considerable loss of power at low speeds. In other words, the converter operates at low efficiency at starting and at low speeds in order to obtain the desired increased low-gear starting effect. The efficiency of the converter increases from zero at starting to about 84 per cent at about 35 miles an hour and then drops off to about 77 per cent at 50 miles an hour. The efficiency of the coupling increases from about 89 per cent at 50 miles an hour to about 98 per cent at 120 miles an hour, under full load of 1,250 hp. for the size of coupling used. The combined unit is only 29½ in. in diameter over flanges and 27½ in. long, but will transmit up to 1,500 hp., but with slightly lower efficiency than for the nominal rating of 1,250 hp. The efficiency, however, increases at lower ratings.

The method of operation is to admit a light transmission oil flowing (but not under pressure) to the converter, the impeller blades of which are of such shape that they throw the oil with multiplying force against the blades of the runner, driving it and the driven shaft to which it is keyed.*

When the speed of the locomotive increases to about 50 miles an hour, the oil supply is cut off the converter and the oil in it quickly drains outward and drops to the lower portion of the housing, from which it is pumped back to the oil cooler. In the meantime oil has been admitted to the coupling. This oil is thrown from the

* Except for efficiency losses, the horsepower input and output in the torque converter are the same irrespective of speed differentials between the driving and driven runners. This is effected by stationary reaction blading attached to the housing through which the oil returns from the driven runner to the intake of the impellers on the driving shaft.—Editor.



31—Butterfly throttle valve to combustion power turbines
32—Hydraulic-coupling clutch
33—Oil-burner fuel pump
34—Electric storage battery
35—Train steam-heating boilers
36—Train steam-heating water storage, 1,600 gal.
37—Train steam-heating water storage, 1,600 gal.
38—Water-filling and equalizing pipe between storage tanks 36 and 37
39—Water-filling man holes
40-41—Diesel-engine and train-heating-boiler fuel-oil storage
42—Fuel-oil filling and equalizing pipes between storage tanks 40 and 41
43—Compressed-air reservoirs for air brakes
44—Sand storage for front truck
45—Sand storage for back truck
46—Electric switchboard locker (above)
47—Train-control mechanism locker (below)
48-49—Motor-driven turbine lubricating-oil cooling fans
50—Air-admission louvers
51—Radiators for transmission and reduction-gear oil
52—Motor-driven fan for Diesel-engine cooling
53—Turbine lubricating-oil pumps
54—Oil circulating pumps
55—Fuel-oil transfer pump
56—Combustion fuel-oil storage (5,000 gal.) also lubricating and transmission oil storage
57—Bulkheads
58—Motor-driven air compressors
59—Clothes lockers
60—Brake drums

worm-gear drive — Starting tractive force, 70,000 lb.; maximum speed, 120 m.p.h.

impeller vanes against the runner vanes and transmits power in so doing.†

To cut off the power from the coupling the oil is shut off and is automatically discharged quickly from the coupling. There is no metal contact between the impellers and the runners and the oil, when being used, is pumped continuously through a cooler and back to the converter or coupling, whichever is being used. When there is no oil in the converters or couplings, they turn freely with only air windage resistance.

The reverse motion sets are idling and turning in the opposite direction and at the same speed as the driving sets and the windage losses in power are only 2 per cent at 85, 3 per cent at 100, and 5 per cent at 120 miles an hour, and there are several practical methods of considerably reducing this.

The maximum speed of the converters, couplings, worm and driving shafts will be 3,000 r. p. m.

The turbine shaft drives the forward-motion pinion, which in turn drives a gear on each of the two converter and coupling shafts, on the opposite end of which are mounted gears which drive other gears on the driving shafts to each of the truck driving axles, two per truck.

On each driving axle is mounted a worm gear which is driven by a cone worm mounted on a shaft which extends from the hydraulic transmission carried on the main locomotive frame. Suitable universal couplings are mounted on each driving shaft to permit movement of this shaft due to movement of the driving axles.

As far as can be determined, this hydraulic transmission will have a higher efficiency at the higher speeds of the locomotive and will stand more abuse than an electrical or a direct gear transmission. The hydraulic transmission cushions all shocks between the driving axle and the turbine and forms an equivalent to a differential between the two driving axles on each truck and thus makes it possible to run with a reasonable difference in the diameters of the two pairs of driving wheels even though they are driven from the same driving pinion

† The coupling has a constant torque ratio irrespective of speed differentials between the driving and driven runners.—Editor.

on the turbine shaft. It also permits a rugged, practical dynamic brake on all driving wheels which will work in conjunction and harmony at all times with the automatic air brakes. This should greatly reduce driving-tire and other wheel-tread wear.

The cone type worm and worm gear proposed are manufactured by the Michigan Tool Company, Detroit, Mich., and are of the lightest weight but of the most rugged and efficient construction it is possible to obtain and, according to records, will give long life with low maintenance cost.

The universal joints will be furnished by the Spicer Manufacturing Company, Toledo, Ohio, one of the largest manufacturers of this type of equipment.

A 5,000-Hp. Combustion-Turbine Locomotive

The construction of the proposed locomotive consists of a long steel fabricated main frame and cab carried on two eight-wheel trucks having cast-steel frames. Two pairs of driving wheels and two pairs of load-carrying or guiding wheels are provided for each truck. Both driving and guiding axles are to have roller bearings located between the wheels. This locates the wheels outside the frames so that steel tires can be used on the 52-in. driving wheels and replacement of the driving tires can be made without dropping the wheels away from the truck frame. This permits the changing of tires instead of the changing of the entire unit of wheels, axles, journal boxes, driving worm, gear housing, etc. The guiding wheels are to be rolled steel 40 in. in diameter.

The length of the locomotive over pulling faces of couplers is to be 88 ft. and the overall width and height of cab 10 ft. 2 in. and 15 ft. 3 in., respectively.

The maximum weight on each truck at the rail will be 250,000 lb., making a total of 500,000 lb. for the locomotive in working order. The starting tractive force will be 70,000 lb. and the maximum speed 120 miles an hour.

The main frame will be of welded-steel construction with storage compartments for carrying 5,000 gallons of fuel oil, 3,000 gallons of water for train heating, and 1,000 gallons of Diesel fuel oil for the starting Diesel engine and the three train heating boilers.

The fabricated-steel frame will be of well-type construction at the center to provide space for the two driving combustion turbines and the two hydraulic transmissions, one such set for each of the two trucks. Either truck may be operated separately.

The starting of the first power unit is to be accomplished by means of a small Diesel engine. The starting of the second unit will be done by a small combustion turbine connected by combustion gas pipes (not shown) from the first power unit.

The small auxiliary combustion turbine will furnish power to drive an electric generator for lighting, battery charging, auxiliary motors, etc., and also for train cars if so desired. The small Diesel starting engine will also be coupled to an additional electric generator to be used as an auxiliary when the locomotive is standing or the combustion turbines not operating, or to furnish additional electric current when required. No auxiliaries are driven from the two power turbines.

Five large fans, one motor-driven and four turbine-driven, are provided for cooling the transmission oil for the hydraulic converters and couplings. This cooling for the transmission is considered ample for slow-speed operation in hot weather and will be less than required for the same power with Diesel engines. Five other small motor-driven cooling fans are to be furnished, one for the Diesel engine cooling and four for turbine bearing oil cooling.

Two standard motor-driven air compressors of 80 cu. ft. per min. capacity are to be used to furnish compressed air for brakes.

Three steam boilers of 2,250 lb. per hour capacity at 200 lb. pressure will furnish steam for train heating.

The advantages which the committee sets forth as possible of attainment with the combustion-turbine locomotive may be briefly summarized as follows. No water will be required except for train heating. Low-priced Bunker C fuel oil can be used at a cost per gallon of about half that of the more refined Diesel oil. Locomotives with capacities up to 6,000 hp. can be built in single units instead of two or three as required with the Diesel. The resulting reduction in locomotive weight should make it possible for a 5,000-hp. combustion turbine locomotive to handle the same train as a 6,000-hp. Diesel locomotive with the same combined weight-horsepower ratio. The locomotive is free from reciprocating parts and has the least number of parts and equipment to service, inspect, and maintain. The combined cost of fuel oil and lubricating oil for a 5,000-hp. combustion-turbine locomotive should be approximately one-third less than that for a 6,000-hp. Diesel locomotive required for the same train. Not only will the reduction in the number of wheels, axles, journal boxes, brakes and couplers, and steam, air, and water connections favorably affect the first-cost comparison with Diesel locomotives, but will reduce the amount of servicing and maintenance as well as the amount of store stock which will have to be carried. The possibilities of burning pulverized coal are greater with the combustion-turbine locomotive than with either the steam or Diesel locomotive.

Flow of Air through The Locomotive Grates

(*Continued from page 143*)

instances, and the constriction under the draft partially eliminated. Open arches may be discontinued so that the flame travel from the front of the firebox will be lengthened by forcing the gases to travel around the arch instead of passing directly into the boiler tubes without allowing time for complete combustion. There is another point which warrants serious thought. The grates in the majority of locomotives slope from the rear toward the front. This evidently was done to aid hand firing, making it easier to reach the front of the firebox with the coal. This aid is not required by the stoker. There is a tendency for the vibration of the locomotive to jolt the fire from the rear of the grates to the front, increasing the resistance of the front part of the fire through the addition of the ash from the rear. This increased resistance is at the point of the least draft, and compounds the effect of this reduced draft in retarding combustion. Some railroads have levelled their grates and have obtained good results.

While considerable progress has been made, there is still much to be done before locomotive drafting may be reduced to an exact science. It is much easier to obtain results, however, when the proper function of each of the various appliances is understood, even though the exact measurement of the effect of a given amount of adjustment is not known. It is apparent that proper grate design is a major factor in drafting locomotives, but there has been a tendency to neglect its effect excepting where necessity has forced consideration.

Cor-Ten Hopper Cars Show Low Weight Loss

Additional data supplementing tests already reported on the relative life of copper steel and corrosion resistant high tensile steel confirms the earlier claims of longer car life when high tensile steel is used.

An eastern railroad weighed 100 hopper cars designed for handling coke when they were delivered and again after 40 months of service. A second group of 100 cars for similar service, built of U. S. S. Cor-Ten Steel, were likewise weighed as received and again after 31 months of service.

The average initial weight of the copper-steel cars was 54,390 lb. as compared to 41,978 lb. for the Cor-Ten bodies. After an average life of 39.8 months the average weight of the copper-steel cars was 53,158 lb. while the Cor-Ten cars after 31.2 months of service averaged 41,570 lb. These figures show a loss of weight for the copper-steel cars of 1,232 lb. or 30.94 lb. per car per month as against 408 lb. or 13.05 lb. per car per month for the Cor-Ten units, indicating that cars built of Cor-Ten lose weight less than half as rapidly as do similar copper-steel cars.

The cars under test were all equipped with rolled-steel multiple-wear wheels. No specific information is available regarding the difference in weight of wheels on these particular cars at the first and second weighings. It has been definitely established, however, that no substantial proportion of wheels was replaced on either class of cars.

On the basis of the records obtained it is conservative to estimate that the loss in weight of Cor-Ten is only 42 per cent of that found for copper steel, and consequently, that Cor-Ten will last at least 2.37 times as long as copper steel of equal thickness.

Design of Diesel Locomotives

(*Continued from page 136*)

Allison metal is being used for the pressure side of crankshaft bearings with Satco metal in the non-pressure half of bearings. The capacity of lubricating oil pumps has been increased. Air for engine radiators is now carried through ducts eliminating dirt from this source getting in the enginerooms.

These improvements make it possible to run a Diesel engine 100,000 miles in road service before it is dismantled for inspection.

Wheels have been greatly improved. The service life of present wheels is about 250,000 miles with about 84,000 miles between machinings.

A crankshaft crank-throw grinding machine, designed by J. P. Morris, general mechanical assistant, was built on the Santa Fe and is now used at important terminals where the work of regrinding crankshafts is done. It will grind the crank throws of either a V-type or vertical engine. This machine has been developed so that it takes care of this work on all types of Diesel engines in service at the present time. With this machine, we expect to make 1½ million miles in road service before removing crankshafts from the Diesel engines.

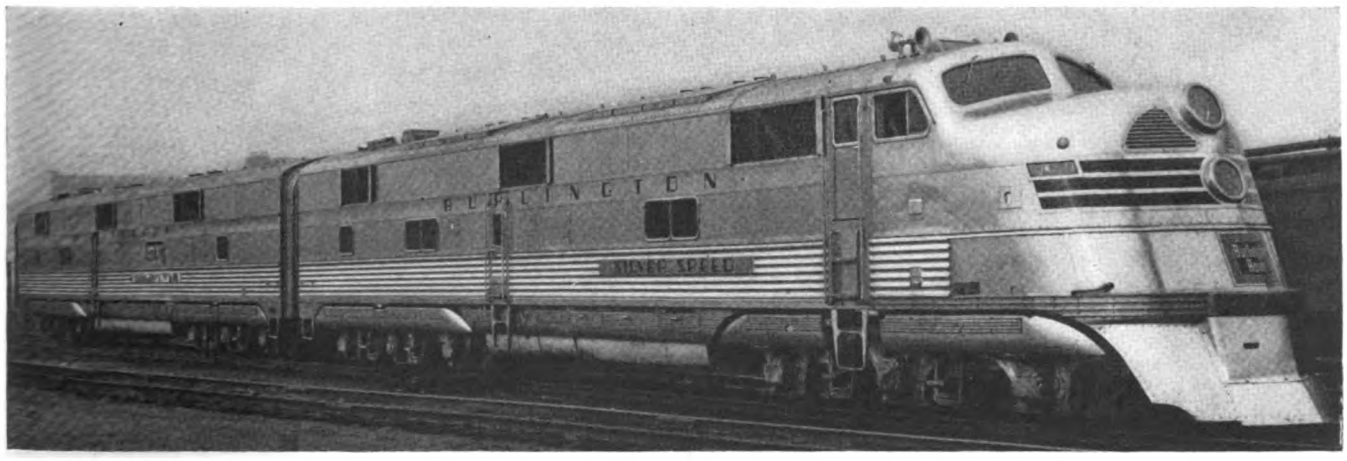
It was also considered necessary to design and build a six-wheel truck having the traction motors located on the No. 2 and No. 3 wheels, using the front wheels of the new design of truck to guide the locomotive. Two locomotive units have been equipped with this type truck and the performance has been satisfactory.

The Diesel-electric locomotive is giving a good account of itself in switching and high-speed passenger service which has resulted in further activity among locomotive builders. A 2,000-hp. passenger locomotive, powered with two 1,000-hp. four-cycle Diesel engines has been built and placed in service. Exponents of the mechanical transmission, using torque convertors, have been busy and placing in service several locomotives. There is also on test a 5,400-hp. freight locomotive powered with four two-cycle, 1,350-hp. Diesel engines. All these new developments will be watched with interest, especially the freight locomotive which is invading a field in which the steam locomotive was thought to be supreme.

During the short development period through which the Diesel locomotive has gone we have seen the transition from a single-engine-powered car of 600 hp. to locomotive units having two Diesel engines of 1,000 hp. each and operation of these locomotive units in multiples of two or three units making a Diesel locomotive of 4,000 to 6,000 hp.

In view of the past performance and improvements, we have a right to expect that future Diesel locomotives will be still more economical to operate and have greater continuous load capacity combined with less weight.

* * *



One of the three 4,000-hp. Diesel-electric locomotives recently built for the C. B. & Q. by the Electro-Motive Corporation—140 ft. long, weighs 308 tons—Driven by four General Motors 12-cyl. 2-cycle, V-type Diesel engines (two in each unit) developing 1,000 hp. per engine at 800 r. p. m.

EDITORIALS

Winter Weather and Brake-Rigging Failures

Epidemics seem to be part of life in most places where human beings live together and they're not uncommon in the railroad business. If it isn't an epidemic of hot boxes, which breaks out almost any time during the year and particularly in the springtime, it may be broken springs or slid-flat wheels. At any rate it's always something and this winter was no exception. Several of our mechanical department friends have complained about the unusual number of failures of brake beams and other truck rigging parts.

When an epidemic breaks out it is only natural that every effort should be directed toward getting at the source of the trouble and correcting it. In a case like this it is not unnatural to suspect at first that possibly there may be something faulty in the design of parts or in the manner of their application but a little investigation usually discloses the fact that the difficulties did not occur on any particular design or on the equipment of any particular road.

There are many factors which conspire against the railroads in the matter of truck failures in extreme winter weather. From the standpoint of materials it is obvious that metal parts are more easily fractured at low temperatures and the loads that are imposed on these parts may be more severe in winter operation. Rough track and out-of-round wheels set up serious vibrations that are transmitted to brake beams and brake hangers and the accumulation of ice and snow on the roadbed may easily provide the means for a blow from a piece of ice heavy enough to break a part under such conditions.

The prevention of mechanical failures, irrespective of the character of equipment, is to a large extent in direct relation to the adequacy and efficiency of inspection. When car trucks are covered with ice and snow and the thermometer is down around zero it is virtually impossible for a car inspector to do as good a job as can be done in warmer weather. This fact can not be used as the excuse for a poor job of inspection, for nothing less than 100 per cent can be considered worth while, but it is a fact that has to be faced with the realization that winter operation sets up conditions that demand more careful inspection than may be needed in less severe weather.

Take the matter of worn brake hangers, for instance. Every road has set up standards as to the limit of wear before they should be replaced. Regardless of the fact that the truck may be covered with ice, an inspector must keep constantly in mind that under the ice may be a brake hanger worn to the limit. If he passes it by and its worn condition contributes to its breakage then a train delay may result.

It may be stepping out into deep water to suggest that the transportation department may in some measure be partly responsible for many of the failures of freight-car equipment that are charged to the mechanical department but it might be well for transportation department men—despatchers, trainmasters and yardmasters—to remember that, if a train pulls into a terminal yard in zero weather a half-hour or an hour late and they expect to get it "out of town" in 30 minutes, the chances are ten-to-one that a thorough job of inspection is not going to be possible. A good inspection job in the train yard takes more time or more men in winter than in summer. As to the parts that actually fail, only a consistent study of the nature of the failures in relation to the design and the materials used will permit such changes in design as are necessary to adapt the parts to the rigors of the unusual condition.

Locomotive Condition as Reflected by the I. C. C. Report

Each year, the Bureau of Locomotive Inspection makes an annual report of its activities to the Interstate Commerce Commission which is both comprehensive and illuminating. High points of the report for the fiscal year ended June 30, 1939, were outlined in an article in the February *Railway Mechanical Engineer* and indicated a general improvement in the condition of both steam and other types of locomotives operating on railroads in this country.

One of the things not included in the article, on account of lack of space, was the relative standing of the various railroads as regards the condition of locomotives examined by the I. C. C. inspectors. The Bureau report lists by individual roads the kind and total number of defects found, locomotive ownership reported, number of locomotives inspected, locomotives found defective, percentage of locomotives inspected found defective and number of locomotives ordered out of service. Perhaps the most significant of these figures is the second last, namely, the ratio of locomotives found defective to those inspected, and a study of the records on this basis presents some interesting facts.

Eliminating the smaller railroads and considering only those with ownerships exceeding 300, 500 and 1,000 locomotives, the three roads in each class which showed

the lowest percentages of defective locomotives are rated in the following order in the 1939 report: (Over 300 locomotives) Wabash, Texas & Pacific, Nickel Plate; (over 500 locomotives) Seaboard Air Line, St. Louis-San Francisco, Missouri Pacific; (over 1,000 locomotives) Burlington, Southern, Illinois Central. Some remarkable records have been made in reducing the percentage of locomotives found defective, and the Wabash, for example, which now occupies a leading position among the larger roads, reduced its figure from 72 per cent in 1924 to 0.4 per cent in 1939. Almost equally spectacular improvements have been made on some of the largest railroads which do not always achieve the lowest percentage figures, due primarily to large ownership of locomotives operating on widely-extended lines and not so easy to supervise. For example, the Pennsylvania, with 4,292 locomotives, reduced its percentage found defective from 73 per cent in 1924, to 7 per cent in 1939. The New York Central, with 3,241 locomotives, reduced its figure from 50 per cent in 1924 to 7 per cent in 1939. In general, by far the great majority of all railroads have made quite impressive reductions in percentage of defective locomotives over a period of years.

Just what does a low percentage of defective locomotives, as shown in the reports of the Bureau of Locomotive Inspection really mean? How much significance may be attributed to these comparative figures? While a favorable rating is undoubtedly highly creditable to any railroad, it is by no means the sole criterion on which locomotive condition should be judged. In the first place, the locomotive boiler inspection law covers primarily defects which have a bearing on safe operation and no attempt is made to check or evaluate those factors which influence the capacity, efficiency or ability of a locomotive to do a good day's work. For example, as long as boiler inspections and tests are made on time and indicate full compliance with the law, the government inspector doesn't care whether the brick arch is in the best condition to promote efficient combustion, or the feedwater heater functioning to reclaim the maximum number of heat units from the exhaust steam. External steam leaks are watched with a hawk eye, but the inspector does not look for steam leaks in the front end which may seriously interfere with drafting. Similarly, the inspector does not concern himself with the setting of valves which govern steam distribution to the cylinders and, as long as wheel-tread contours and lateral play are within the specified limits, he doesn't care particularly if incorrect counterbalance conditions cause the locomotive to kink rails every time it operates above a certain limiting speed.

Considering those details of locomotive condition which are covered by the boiler inspection and safety-appliance laws, it is inevitable that some of the rules should be of more vital importance than others and some, in fact, have only a very minor bearing on safe operation. No two men could be expected to see exactly eye to eye on these details and, consequently, the human element enters very largely into the question of inspecting locomotives for compliance with the federal law. It is obvious that the mechanical supervisors, especially on relatively small roads, are in a position to study the characteristics of individual inspectors, concentrate on correcting the defects to which each man seems to be giving the most attention and thus make a good record on the books, when possibly some other rather important and undersirable conditions are being overlooked.

While the standing of individual railroads, with respect to the locomotives found defective as a percentage of those examined by the government inspectors does not always tell the entire story, even from a safety standpoint, and no real measure is given of relative locomotive capacity or efficiency, there can be no question of the highly constructive purpose served by the I. C. C. Bureau of Locomotive Inspection. Since its inception in 1911, this Bureau has proved a great boon to the railroads and effected a tremendous improvement in motive power from the point of view of safe operation. The ability and good judgment of the Bureau's inspectors are of the utmost importance and the caliber of the men now working under the direction of Chief Inspector John M. Hall is indicated in some measure by the fact that no formal appeal was taken from an inspector's decision by any railroad during the year covered in the 1939 report.

Car-Wheel Grinding Effects Economies

The subject of car-wheel grinding has occupied the attention of railway mechanical officers for many years and is at present receiving increased attention because of the urge for further economies by lengthening the effective service life of car wheels. Not only are used wheels being ground to remove slid-flat spots, but new wheels are ground by many roads to assure smooth treads concentric with the journals. The strongest kind of recommendation for car-wheel grinding is given in the Association of American Railroads Wheel and Axle Manual, which states specifically in Section 19 that this method of securing improved service from new wheels and reclaiming worn wheels presents the opportunity for savings of such magnitude that the installation of a modern machine for grinding car wheels will pay for itself in a short time. The grinding of both chilled-iron and wrought-steel wheels is recommended by authorized methods in which the entire circumference of the wheel tread is ground truly concentric with the journal. Necessary precautions include the exercise and proper care in the selection of wheels to be reclaimed and also in the use of grinding wheels adapted to produce the desired results, dependent upon the kind of metal in the different wheels being ground.

The modern car-wheel grinding machine is capable of producing a very satisfactory output. According to the Manual it is possible to grind on such a machine

an average of 16 pairs of slid-flat cast-iron wheels in eight hours, 32 pairs of new cast-iron wheels, or 20 to 24 pairs of slid-flat wrought-steel wheels. Information submitted at a recent meeting of car-department supervisors in St. Louis, Mo., indicates that one large western railroad, equipped with two car-wheel grinding machines, reclaimed over 8,500 pairs of slid-flat wheels and ground 4,250 pairs of new wheels in a period of 4½ years, the total cost of labor, material and overhead during this period being estimated at $11,000 and the net saving on slid-flat wheels alone, about $100,000. This is surely an impressive record which can, no doubt, be duplicated or possibly exceeded on other roads.

Cutting the Cost of Compressed Air

Without becoming involved in any detailed presentation of statistical data to prove the point, it is probably reasonably safe to assume that the railroad industry is one of the largest users of compressed air. It is used in both car and locomotive repair shops and in numerous installations in train yards for the operation of switches and for pumping up train lines. All of these uses require literally thousands of miles of pipe lines, most of which are of necessity placed in locations which make their inspection and maintenance extremely difficult. The result has been an increasing amount of leakage in the older installations and a consequent higher demand on the plant furnishing the air, not to mention the increased cost per cubic foot delivered at the point of use.

Many factors have combined to make the railroads conscious of the cost of compressed air. There may be some question as to which department—the car or the locomotive—deserves the most credit for the ingenuity shown in the development of home-made air-operated devices but there is no question concerning the fact that when one looks over the hundreds of shop "tools" that have an air cylinder as a nucleus it is small wonder that the average railroad repair shop needs a plentiful supply of compressed air. The very process of developing these varied devices, with their inefficient use of an expensive source of power, is one of the reasons why many railroad mechanical men, in collaboration with the engineering and electrical departments, are now making careful surveys of the whole problem of the supply and use of compressed air.

In the past the centrally located power plant has been the source of this type of power. There are still in service many steam-driven compressors supplying all of the demand for a given area. As the cost of electrical energy has decreased with its broadening use a number of the steam-driven compressors have been replaced by motor-driven compressors with the result that the cost of compressed air is more definitely related to the demand.

The demand for air depends on three factors, the consumption by tools or other air-operated facilities, the transmission losses and the waste by leakage. Consumption, as far as shops are concerned can be definitely controlled by the use of none but the most efficient tools and the maintenance of such tools in good condition; the losses in transmission and the waste by leakage can be controlled by an efficient layout of supply lines and the maintenance of such lines in good condition.

Practically every road of any size has at some time made distribution-of-power studies with the idea of determining where and how compressed air is used. Anyone who has ever made such a study is aware of the fact that a substantial part of the total supply of air never reaches the place where it is used. Leakage and line losses account for the difference. The fact of real importance developed by these studies is that in many instances, where a large proportion of the air is used at a specific point located at considerable distances from the source of supply, a substantial saving can be effected by the elimination of the long supply lines and the installation of individual motor-driven compressors of sufficient capacity to supply the needs of a single location. As an example, one such study recently made developed the fact that a certain car yard served by a 1,200 cu. ft. compressor could be served by a 300 cu. ft. machine. As a result the old, remote plant was abandoned together with a large part of the old supply lines and with a modern compressor of smaller capacity the cost of compressed air for that location has been substantially reduced.

In the zeal to reduce the expense of operation it should not be assumed that there are not uses for the older plants of larger capacity. Like all such situations each individual case should be considered on its own merits. The important thing is that every situation where power of any kind is used is one worthy of constant study and in many cases the cost of modern facilities can be offset by a high return on the money invested.

New Books

TOOL MAKING. *By Charles Bradford Cole. Published by the American Technical Society, Chicago. 413 pages, cloth bound. Price $3.50.*

This is another "how-to-do-it" book. It leads the inexperienced toolmaker from the simple facts about his personal tools and the equipment provided in the shop, to the processes of the toolmaker's craft. This is done through the actual presentation of typical jobs. These jobs are presented as finished working drawings, and the tools which they represent may be made from these drawings. The section on production tools is valuable for the more experienced toolmaker.



Jim Evans, the roundhouse foreman, bellowed like a bay steer with a hollow horn when the switch engine arrived at the roundhouse with the coach and he learned why

CIRCUMSTANTIAL EVIDENCE

***by* Walt Wyre**

DICK WHEELER, foreman of the car department of the S. P. & W. at Plainville, swore mildly when he read the two traingrams. One was from the division superintendent wanting to know why there was a perpetual shortage of cars for loading carbon black. The other was from the master mechanic stating definitely and emphatically that the allowance would not permit increasing car department forces and that overtime would only be countenanced in case of wrecks, floods, fires, and other emergencies.

While the car foreman was looking over the morning mail, the switch engine rattled down the main line four tracks across from the office. The goat was pulling two cars, one a loaded refrigerator car, and the other a cattle car. The first thing Wheeler noticed was the defect card on each of the cars. Rush jobs, both of them. The switch engine wouldn't be shoving the cars in on the rip track two hours before the usual time for switching the rip unless it was urgent. Besides, loaded reefers are always rush.

While the cars were being shoved in on number one track, the foreman was figuring who he could put on them. Six carmen was all he had on the rip track and four of them were supposed to be assigned to repairing carbon black cars, while the other two did odd jobs of repairing and occasionally helped out in the train yard when the regularly assigned inspectors had more than they could do without delaying trains.

According to the defect cards, the cattle car had a broken coupler yoke while the reefer had a cut journal that called for changing a pair of wheels.

Wheeler walked down the track to see how Charley Anderson, one of the carmen on running repairs, was getting along with a caboose that had been reported six consecutive trips by the conductor. According to the trainman's reports, taking the air gage from the dog house and placing it in another caboose was the most logical method of making the caboose serviceable. It weaved, wobbled, rode hard, had flat wheels, listed to one side, doors and windows were loose, the stove smoked, and the water barrel leaked.

If Anderson was striving for success, he had reversed the rule as usually given, because he had started at the top and was working down. He had removed all of the cupola windows together with the frames. It would take at least two hours for him to repair the windows so that the caboose could be used, and it had to run that night. No use taking him off until it was finished.

"When you get the windows fixed up, tighten that loose grab iron and let it go," Wheeler told the carman. "We'll get some of the other jobs on it next trip," he added.

The other carman, working on running repairs, was replacing some siding on a box car that had suffered a side-swipe. This car was two days overdue being finished. Wheeler decided that one more day of delay wouldn't hurt a lot, so he told the carman to let it go and get started on the defective cattle car. One of the men working on carbon black cars and his helper were assigned to the job of changing out the pair of wheels on the refrigerator car.

WHEN Wheeler returned to the eight-by-ten shack that is called an office, the telephone was ringing insistently.

It was the chief despatcher calling. Chief despatchers never have good news; when it's not bad, it's worse. Eight flat wheels on the streamlined coach coming in on the Limited was the first bit of information the despatcher offered. "And it must be ready to go tomorrow at the same time," he added.

No. 72, the hot-shot gold-ball freight that usually leaves Plainville at least two hours ahead of the Limited, was running late and would get in just ahead of the passenger train was the next thing the despatcher told the car foreman, which sounded very innocent until he said "I want to get 72 out right behind the Limited."

That meant that both trains would have to be inspected at the same time and that two carmen from the rip track would have to help with the inspecting.

Wheeler hung up the receiver and started to leave the office. Just as he reached the door, the phone rang again. "What's the idea hanging up before I finish?" the chief despatcher asked.

"Thought you had finished," Wheeler replied. "What else you got on your mind?"

"Just wanted to ask how you are coming with that reefer and cattle car."

"O. K., I guess, but the men haven't hardly got started on them yet. They were just shoved in on the rip track less than thirty minutes ago."

"Well, I want that cattle car ready to go by four o'clock and the reefer must be ready for No. 80 to pick up tonight."

"That's going to mean taking all the men off carbon black cars," Wheeler told the despatcher.

"We've got to have cars for carbon black. They've opened a new plant that will load two cars a day. If we don't furnish the cars, the T. P. & W. will."

"But——" A click in the telephone interrupted what Wheeler intended to say.

The car foreman looked at his watch. It was just ten minutes until No. 72 was due to pull in on the passing track. He told two of the carmen to let the jobs they were on go long enough to get the passenger and fast freight out of town. Wheeler went to the passenger station.

The Limited came in right on the dot with the rhythmic clickety-clack of the flat wheels of the streamline chair car sounding above the other noises of the train.

"Guess the engineer must have been a little too enthusiastic with his air," Wheeler commented when he saw the wheels.

"Where do you want to set it?" the yardmaster came up and asked the car foreman.

Wheeler scratched his head a moment while the yardmaster fidgeted. "Take it to the roundhouse."

"To the roundhouse?" The yardmaster looked as though he wondered who was crazy.

"Yes, to the roundhouse. I can save a lot of time changing wheels by using the drop-pit in the roundhouse. I'll be up there in a few minutes."

Jim Evans, the roundhouse foreman, bellowed like a bay steer with a hollow horn when the switch engine arrived at the roundhouse with the coach and he learned why. "What do they think this is a—car shed?" Evans exploded. "Besides, what does a flock of dusty butts know about using a drop-pit?"

"Don't make no difference to me," the switchman said. "I'll set it out at the stock yard to load sheep in if the boss says so."

At that moment the car foreman came in and interrupted the conversation. "Got a bunch of wheels that have to be turned," Wheeler said, "and figured we could save a lot of time by bringing the car to the roundhouse."

"How many need turning?" Evans asked.

"Four pairs."

"But I need the drop-pit for locomotives," Evans objected. "One track of the pit is already tied up with a dead engine. If you tie up the other track with a passenger coach, I'd be up against it if I had to change a pair of engine wheels."

"What do you want to do with it?" The switchman was getting a little impatient.

"I'll go talk to the master mechanic," Wheeler started to leave.

"Go ahead and shove it in over the drop-pit," the roundhouse foreman growled, "but don't make a habit of it."

THE two carmen assigned to the job of changing the car wheels were the only ones pleased. It gave them a chance to work inside where it was dry and moderately warm instead of working outside where the temperature was well below freezing and a brisk northwest wind whipped particles of snow that stung when it hit.

The streamline coach was spotted for the rear truck first and the carmen and their helpers soon had the truck dropped. The end of the car was supported by heavy wooden horses while the wheels were out.

The machinist that operates the wheel lathe wasn't quite ready to start on the car wheels when they were removed from the truck. He had a pair of drivers in the lathe to be finished first. Then when the two pairs of wheels from the truck were finished and back in place under the car, the hostler was busy and couldn't spot the coach for the other truck. The carmen disconnected brake rods and had everything ready, but couldn't do any more until the coach was spotted. Forty minutes were lost waiting for the hostler.

Just before five o'clock and quitting time, Wheeler went to the roundhouse to see how they were getting along with the coach. The wheel lathe operator had just started turning the first pair of wheels from the second truck. It would take at least two hours and that with good luck before the car would be ready to go. Two carmen and two helpers—eight hours overtime! On top of that there had been a delay waiting to get the new coupler yoke riveted to replace the broken one on the cattle car and it wasn't finished; wouldn't be until six o'clock and another hour of overtime for a carman and helper. The trainmaster had thrown two fits and was working up to another when Wheeler saw him last.

The five o'clock whistle blew just as the wheel lathe operator was ready to take the finishing cut on the pair of wheels. He stopped the machine, picked up a piece of waste and began wiping his hands.

"Go ahead, finish the wheels," said the car foreman.

"O. K.," the machinist said, "but the overtime will be charged to the car department."

Wheeler groaned, then groaned again as he figured the net results of the day. Two carbon black cars finished when there should have been six! Eleven hours overtime, figuring the machinist on the wheel lathe an hour, when there shouldn't have been any! At any rate the slid flat wheels on the passenger coach was unusual and would help explain some of it. He shrugged his shoulders and started back to the office. There was still a few reports to be finished before he could call it a day and go home.

Next day wasn't so bad. Five carbon black cars were O. K.'d and there wasn't any overtime. Wheeler was beginning to breathe a little easier. That night he was sleeping peacefully dreaming of a steam heated car shed that had plenty of room, a traveling overhead crane and other conveniences. He was just adding an air conditioned room for painting cars when the rattle of the telephone tore down the whole outfit.

It was the second trick despatcher calling to tell him that the same streamline chair car had slid the wheels again and would have to be cut out.

"Set it out. I'll make arrangements to have the car taken to the roundhouse first thing in the morning."

The first time the wheels were slid flat, the blame was placed on the engineer handling the train. The next time it was decided that the trouble was perhaps in the braking system of the car and the blame was on the car department.

Wheeler instructed his air man to check everything on the car that might possibly cause the brakes to stick and take no chances.

"It looks peculiar to me," the air man said, "that it should always wait until it's on this division to slide the wheels."

"That's right," Wheeler agreed. "It does seem peculiar that it would run O. K. nearly three thousand miles then start sliding the wheels. Wonder if by any chance it was the same engineer in both instances.

Investigation showed that Dick Harrison was the hoghead pulling the Limited both times the wheels were slid, and, peculiarly enough, Harrison wouldn't ordinarily have been running on the east end. He had traded runs for one trip with another engineer for some unknown reason.

The trainmaster, all hot and bothered, came to the roundhouse while the car foreman was arguing with the roundhouse foreman over using the drop-pit again.

The air man had pushed his portable test cart to the roundhouse and was waiting for the car to be pushed into the roundhouse when the trainmaster came in. The official had learned about Harrison being engineer on the Limited both times the coach wheels were slid.

"You'd better find some defect in the air," he told the air man, "or else Mr. Harrison may get a nice long vacation."

"Harrison is a good engineer," Wheeler protested.

"Yeah," Evans added, "I always thought he was one of the best engineers on the Plains Division."

"Maybe he is," the trainmaster agreed, "but looks like he has slipped twice in the same place this time. It wouldn't be so bad if everybody wasn't watching these streamline coaches."

ALL day long Wheeler wondered about the car, trying to figure what caused the brakes to slide the wheels. When the air man told him that the braking equipment tested O. K. that only added to the mystery.

"The new type control valve is pretty sensitive," the air man said, "but it works fine."

"Yes, but all of the engineers have been warned about them. There was a letter put out when the streamline coaches were first placed in service on the Limited."

"Well, it just looks to me like using one or two light weight cars with the rest of the train standard equipment don't work so good," the air man said as he turned to leave.

About four o'clock the trainmaster came to the car foreman's office to learn if the air on the streamlined coach had tested O. K.

"Well, there's nothing left but to hold Harrison out of service when he comes in. Maybe he can explain what caused it when we hold the investigation."

"It'll be hard to prove it was the engineer's fault," Wheeler said.

"Be hard to prove it wasn't," the trainmaster replied as he left the office.

After the official had left, the car foreman sat thinking. He knew Harrison to be a competent engineer and couldn't believe him to be entirely responsible for the trouble. The more Wheeler thought about it the more he was convinced that some defect in the equipment had caused the trouble.

Suddenly he rose from his chair and started at a fast walk towards the despatcher's office.

"Where are your train sheets for the past three days?" he asked the chief dispatcher.

"Today's sheet is on the desk. The others are in the top drawer of that desk."

Wheeler studied the sheets for several minutes, then took a notebook from his pocket and made a notation in it. Then he went to the trainmaster's office.

"Baggage car No. 2902 will be on the Limited tomorrow morning," Wheeler said rather than asked.

"I don't know off-hand," the trainmaster replied. "Why?"

"Well, I'd like for you to make arrangements to have it set out here."

"We haven't had any reports on it," the trainmaster objected. "Why should it be set out? What's the matter with it?"

"To tell the truth, I don't know of anything, but I've been doing a little figuring. Both times the wheels have been slid on the streamline coach, it was on this end of the division, this side of Sanford."

"That's right," the despatcher agreed. "And both times Harrison was the engineer."

"Just a coincidence," Wheeler said. "That is, if my theory is right. Baggage car 2902 was in the train, too, just ahead of the streamline coach each time."

"Maybe that was a coincidence. There were at least ten other cars in the train. Why pick on the baggage car?"

"Because," Wheeler said, "the baggage car just runs on this end of the division. It sets out at Sanford and again at Middleton. I'd like to check it over."

"O. K.," the trainmaster said, "but if you want to save Harrison's hide you'd better work fast. The investigation is set for two o'clock tomorrow afternoon."

Next morning suspect number two—baggage car 2902—was cut out of the Limited and set in on the rip track. Wheeler went with the air man to make the test.

At five minutes before two o'clock, Wheeler went to the trainmaster's office where the investigation was to be held. Engineer Harrison and his representative arrived about two minutes later.

"Well, gentlemen, I see you are on time." The trainmaster looked at his watch. "The stenographer will be here in just a moment."

"I believe," Wheeler began, "when you hear what I have to say, there won't be any investigation."

"What?" barked the trainmaster.

"Yes, baggage car 2902 caused the brakes to apply and slide the wheels on the streamline coach."

"Never heard of such a thing," the trainmaster said. "But, I'm willing to learn. How did it happen?"

"Well," Wheeler said, "the more I thought the more I was convinced our friend was an innocent bystander. When I checked up and found the car only gave trouble when baggage car 2902 was with it, that set me thinking."

"What did you find?" the trainmaster interrupted.

"A leak in the train line! Just a minute, give me time, and I'll answer your question before you ask it. In the first place, the braking equipment on the streamline coach is more sensitive than that on the older style cars. In the second place, the car is lighter and does not require as heavy brake application to slide the wheels. That's my theory on it and I'd like to see it tried. The leak in the train line on the baggage car wasn't much and wouldn't ordinarily cause any trouble. I'd like to see how it works out since the defective pipe is replaced."

"Seems a little like circumstantial evidence," the trainmaster said, "but we'll hold up on the investigation until the car makes a couple of trips with the baggage car in the train."

"Thanks," Harrison said to Wheeler. "Next thing you'll be working with the G-men."

The investigation was never held and Wheeler has been too busy trying to catch up on carbon black cars and explaining overtime to think about it any more.

Maybe it was the leaky train line that caused the wheels to slide, then again maybe the engineer unloaded twenty brownies for the first offense and an investigation with possible dismissal for the second.

What do you think?

Air Brake Questions and Answers

D-22-A Passenger Control Valve (Continued)

555—*Q.—What causes the adjuster to lock?* A.—If the adjuster crosshead is allowed to work out to the outer end of the adjuster body it will become locked.

556—*Q.—In this event how can it be released?* A.—The stop screw in the end of the ratchet nut should be loosened about one-half turn, the ratchet nut rotated one-eighth turn to the right to free the pawl, and then turned to the left to let out the required slack. The workman should make certain that the stop screw is retightened.

557—*Q.—What devices are used to permit the conductor to obtain an emergency application?* A.—The B-3-B conductor's valve and the E-3 application valve.

558—*Q.—Where are they located?* A.—The B-3-B conductor's valve, with a cord attached, is located at each end of the car. An E-3 application valve is located at each end of the car and is connected to the brake pipe.

559—*Q.—How is the application valve connected to the conductor's valve.* A.—A connection from the side of the application valve is joined by a small diameter pipe to the pipe opening of the conductor's valve.

560—*Q.—How is the application valve connected to the brake pipe?* A.—It is so connected that normally, the brake pipe air flows beneath the outer area of the piston valve in the application valve through a small port in this valve to the spring chamber, thence out the side connection to the conductor's valve.

561—*Q.—Is the air pressure now equal on both faces of the piston valve?* A.—Yes.

562—*Q.—There is a valve seat on the lower end of this piston valve. With pressure equal what serves to keep the valve seated?* A.—A spring acting downward on the piston valve, which seals the atmospheric opening below the valve seat.

563—*Q.—What happens when the conductor's valve handle is pulled?* A.—The handle lever unseats the valve, permitting air to escape from the conductor's valve pipe faster than it is supplied through the port in the piston valve of the application valve. This reduces the pressure above the piston quickly with the result that the greater brake pipe pressure on its outer area unseats the valve, creating a large direct opening from the brake pipe to the atmosphere, causing an emergency application of the control valves.

564—*Q.—How many branch pipe tees are used with this equipment and where are they used?* A.—Three, one each in the brake pipe branches to the E-3 application valves and one in the brake pipe branch to the control valve.

565—*Q.—For what purpose is this device used?* A.—The purpose of the branch pipe tee is to prevent moisture that may be deposited in the brake pipe from any cause, draining into the branch pipe connection and from thence into the valves.

566—*Q.—How is this accomplished?* A.—The interior of the fitting is so designed that the outlet from the brake pipe to the branch pipe is at the top. Thus, as air passes through the brake pipe, it flows upward into a chamber and from there through the pipe opening at the side of the branch pipe, the moisture and heavy particles of dirt passing on through the brake pipe.

567—*Q.—What new type angle cock is recommended for use with this equipment?* A.—The double locking angle cock.

568—*Q.—What is the purpose of the double lock?* A.—To prevent accidental movement of the handle such as might be caused by a loose safety chain. This discourages unauthorized tampering.

569—*Q.—How is this additional protection obtained?* A.—A latch, hinged in the handle, must be depressed before the handle can be raised to unlock and turn the cock key. As this requires two distinct and opposite forces, which can only be coordinated manually, the cock is safe against accidental opening from a single force such as that applied by the foot or by a swinging chain. A spring holds the latch in engagement with the socket, locking the socket and handle together so that the handle cannot be raised to clear the stop lugs on the body.

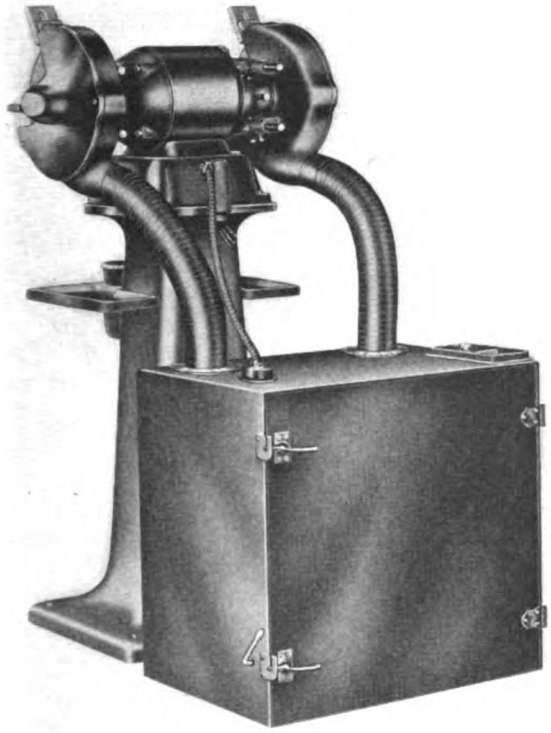
Self-Contained Dust Collector Unit

The Cincinnati Air Master is an efficient dust collector unit that is suitable for use with all makes of grinding and buffing machines having exhaust outlets. The dust and grit-laden air is thoroughly filtered through a series of closely woven fabric and steel-wool filter bags and exhausted through an opening in the top of the cabinet. The heavier particles fall immediately into a large tray in the bottom of the cabinet and a foot lever operates a device for shaking the lighter particles into the tray which is removable for cleaning. The fan motor is regularly connected into the same switch that controls the grinder or buffer and starts simultaneously with the machine.

The motor, suction fan, and filter bags are completely enclosed in a compact, lacquer-finished, insulated cabinet which is mounted on rubber feet to ensure quiet opera-

tion. A metal partition prevents the entrance of dust and grindings into the motor compartment.

The unit is furnished in two sizes, the type AIR-1 for wheels up to 10-in. diameter by 1½-in. face, inclusive, and the type AIR-2 for wheels over 10-in. diameter to



The Cincinnati Air Master dust-collector unit

14-in. diameter by 3-in. face. The units are furnished complete with the piping from the exhaust outlets on the grinder-wheel guards or buffer hoods. The Air Master is made by the Cincinnati Electrical Tool Co., Division of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio.

My Idea of a Stock Car*

By D. V. Costello

Being responsible for the conditioning of stock cars for loading at the National stock yards, I have observed conditions which I feel could be corrected by attention to certain mechanical details.

Stock-Car Side Slats Should Be at Least 1⅛ In. Thick.—As I have observed, cars with slats less than 1⅛ in. thick, are too light for cattle, horses and mules. Very often we have mixed loads which include a few bulls, and they must be tied in the car. They are invariably tied to the slats. Lumber lighter than 1⅛ in. thick often will not hold the animals. We also have a condition daily, of cars arriving with built-in home-made partitions, nailed to the light slats. Very few arrive intact, most of them being down in the car. No doubt we all have noticed that light lumber will not withstand the flexibility of cars; it splinters and breaks.

Stock-Car Side Slats Should Always Be Bolted.—In our daily practice, going in and out of stock cars, conditioning them for stock loading, we note that cars with bolted side slats are always in better shape than nailed slats. We have to carry different size nails, for we are sure to find side slats loose and some down in the car. We also find lots of nails broken off and protruding. You can clean a car with nailed slats, free from all protruding nails and on arriving at destination, the other fellow will find some nails that are broken off and worked out. This condition causes injuries to stock.

Edge-Grain Lumber of a Good Grade Only Should Be Used in the Spacing One Foot to Seven Feet from the Floor.—We find that a good grade of edge-grain lumber, if used in stock cars, will reduce the splintered conditions that we come in contact with daily and will prevent numerous injuries caused by splintered lumber piercing the animals flesh, which causes many claims.

Stock-Car Side Slats Should Be Spaced Three Inches Apart.—The side slats should be spaced 3 in. apart, because slats spaced 4 and 5 in. apart leave openings through which stock can get their feet, and when this happens, the animal becomes excited, falls down, resulting in bruised or broken legs. The spacing of three inches would also be economical when stock cars are used for fruit and vegetable loading, as the opening has to be closed. All we would need would be a 2-in. strip in place of a 4- or 5-in strip. That would reduce the amount of lumber that is being used and save cost in stripping.

The Interior of Stock Cars Should Be Free From Any Projections.—Numerous stock cars are equipped with end doors built inside the car. The slide rails project out about 2 in.; the fastener also sticks out and some come loose and hang down. Most of these fasteners are applied with nails or screws, which work loose and protrude. There are also cars with 3-in. rump boards, reducing the width of the car. Numerous shippers have hay placed on the floor of the car for animals to feed on, and this is where we have a bad condition. The animals, raising their heads come in contact with projecting rump boards. We also have a condition that crops up daily. Cars with broken slats have boards nailed over the broken part and nearly always they are old, rough and splintered board. Any kind of projection inside a stock car will cause injuries.

Stock Bars Should Be Between Door Posts.—A great deal of damage is caused by stock bars in loading and unloading live stock. Some stock cars are equipped with slotted stock bars that are fastened on the inside face of the door post, projecting 2 in. at a point with which stock is continuously coming in contact, when loading and unloading. Stock bars should be set in between the door posts and suspended from a chain bolted to the door post, thus being free to swing outside of the car. Some kind of a bracket should be provided for the stock bar to drop into outside of the car, thus keeping it out of the way when the car is being loaded or unloaded.

Side-Door Hasps Should Be of a Collapsible Type.—The protruding side door hasps on stock cars have caused some of the worst flesh wounds imaginable. I suggest a collapsible type hasp, one that would swing out of the doorway when the car is being loaded or unloaded. I also suggest the use of two hasps about rump board high and two hasps at the bottom of the door, thus having four hasps on each side door, instead of two. I believe that would help preserve the door from being broken and prevent injuries.

Side Doors Should Be Constructed So They Will Swing Out at the Bottom.—We have experienced considerable trouble with stock-car doors that operate in guides and rollers. I suggest that all stock car doors be con-

* Abstract of a short paper presented at the February 20 meeting of the Car Department Association of St. Louis. The author is a gang foreman on the Terminal Railroad Association of St. Louis.

structed so they will swing out at the bottom. Bedding accumulates in both summer and winter and causes delays in opening and closing the doors. I have seen car doors chopped off at the bottom in severe cold weather, so the stock could be unloaded. These doors equipped with guides and rollers very often get out of place and sometimes it is necessary to use jacks to get them in operating position. I also suggest that a strip about 2 in. by 6 in. be bolted the width of the door at the bottom so it will rest on top of the deck, this board to be eased at the top. This will prevent leg injuries at the doorway.

Cars With Metal Roofs Should Be Insulated.—During the summer we have a very bad condition in hog loading. Cars with metal roofs are stored for prospective loading. The hot sun shining down on these metal roofs causes intense heat. If these roofs were insulated and would throw off that heat, I believe we could correct that condition and save thousands of hogs. I suggest also that if the cars were constructed with higher double decks, that would be a great help. The present decks in most cars are too low, which causes considerable head and eye injuries in calf shipping.

More Attention Should Be Paid to Roofs in Regard to Leakage.—The innocent drops of water dripping through a leaky roof cause a multitude of grief. Water, soot and sulphur mixed together and dropping in on stock, especially horses and mules, when they are hot, causes the hair to fall out and I know of several claims that were paid on account of this condition. The animals also become chilled from being wet.

Consideration Should Be Given to the Use of the Same Car for Both Single- and Double-Deck Loading.—Convertible cars would go a long ways in solving the stock-car problem. Numerous times we are called upon to furnish single- and double-deck cars. If cars were equipped so that they could be converted from one to the other, it would be a good plan. When orders are placed for double-deck cars and we have to furnish single-deck cars, that doubles the number of cars, requires more track room, extra switching and per diem, and longer trains. If we had some kind of a double-deck that could be raised or lowered, and operated on a winding shaft from outside of the car, it would solve one of the problems we have today. I know of but one railroad that has this arrangement now.

The present method of constructing partitions is expensive and results in many damaged slats. Possibly cars could be constructed with a standard partition system, much the same as the cars for automobile parts loading.

Balancing High-Speed Rotating Parts

The ever-growing demand for higher operating speeds has emphasized the need for some means of quickly and accurately measuring and locating static and dynamic unbalance in revolving parts. The Gisholt Machine Company, Madison, Wis., has developed an extensive line of Dynetric balancing machines for this purpose. The smaller machines take parts weighing as little as a fraction of a pound, while the larger machines are built to accommodate much larger and heavier parts, such as, for example, Diesel locomotive generator and motor armatures, mounted car wheels, etc., in the railroad field. Several of these machines are now in successful use in railroad and equipment builders' shops. In developing them, Gisholt acknowledges the co-operation of the Westinghouse Research Laboratories at East Pittsburgh, Pa., where the first balancing machine of this type was conceived and built.

Type 3U Dynetric Balancing Machine

The Type 3U Dynetric balancer, illustrated in Fig. 1, was built to balance rotating parts of train and locomotive equipment. This machine will measure and locate the unbalance in parts up to 60 in. in diameter and 80 in. between bearing shoulders. The machine is driven by a 20-hp. induction motor through a reduction gear which gives balancing speeds of 300, 450 and 600 r.p.m.

To handle the wide variety of work encountered in transportation equipment, the machine is supplied with two sizes of work-supporting structures, arranged so as to make possible the change from one type of structure to the other in approximately 20 min. The lighter type of work-supporting structure permits of measuring and locating the unbalance in parts weighing up to 2,000 lbs. Therefore this structure is used for balancing generator armatures for car-lighting equipment, fans or blowers for air-conditioning equipment and armatures for traction motors. Thus, this lighter type of work-supporting structure will handle all equipment on which there is a volume of parts requiring maintenance. The heavier type of work-supporting structure is used for measuring and locating unbalance in parts weighing from 1,000 to 7,000 lb. This structure, therefore, may be used for car-wheel assemblies, large generator armatures and other heavy parts as well as for large traction armatures if desired. The wide overlap in weight capacities indicated greatly reduces the frequency of changing from one type of structure to the other.

The traction-wheel assembly, weighing 3,200 lb. and shown in Fig. 2, required the addition or removal of 2.025 lb. of weight at a radius of 14¼ in. on the wheel adjacent to the driving gear and required the addition or removal of 1.235 lb. of weight at a radius of 14¼ in. on the other wheel. At a track speed of 120 m.p.h. on a wheel speed of 1,120 r.p.m., these unbalances represent a force of 1,040 lb. at the wheel nearest the driving gear and a force of 680 lb. in the other wheel. These forces were present even though the wheels are rolled forgings turned all over and ground on the tread. Because of the restrictions on removal or addition of metal to car-wheel assemblies by any method which might initiate a fracture, the actual application of these corrections has not been accomplished in practice. A mechanical bonding process which will not influence the physical structure of the wheel, such as metal spraying, could possibly be used.

The traction-motor armature, weighing approximately 2,000 lb., shown in Fig. 1, required the addition of 0.56 lb. of weight at a radius of 6¾ in. on the commutator end and a weight of 0.265 lb. at a radius of 11¼ in. on the fan end of the armature. At a top motor speed of 2.200 r.p.m., these unbalances become forces of 520 lb. at the commutator end and 430 lb. at the fan end of the armature. The general method of applying these correction weights is to weld measured lengths of cold-rolled steel to the inside of the commutator shell and to the fan on the other end, the machine indicating the lengths of material required with any given cross section.

Principal Characteristics of the Machine

In the Type 3U balancing machine, the work is supported in a horizontal position in two half-bearings which carry the work on the same bearing surfaces as are used to support the work in its final assembly. These half-bearings are flexibly supported by a lightweight structure, suspended from wires, which permits horizontal vibration of the work piece.

The driving shaft or spindle carries two universal

couplings which are so designed as to offer a negligible resistance to the vibration of the work. One of these flexible couplings is attached to the machine spindle and the other is attached to one end of the work-piece. The spindle is rotated by a suitable motor drive. The machine spindle carries an angularly graduated dial *G* by means of which the angular location of the unbalance is transferred to the work.

As an unbalanced work-piece is rotated, the supporting bearing structure is caused to vibrate. This vibration is mechanically transmitted by means of wires to separate coils which are in the field of powerful double ring magnets. The vibration of the coil in the magnetic field generates an alternating voltage in the coil, and this voltage is directly proportional to the amplitude of the vibration of the work-supporting structure.

The voltages thus generated are greatly amplified so that even the most minute unbalances are distinctly indicated. A vibration as small as .000025 in. will generate a sufficient voltage to permit a reliable reading to be made. The electrical system is easily and quickly adjusted to show the exact location and amount of unbalance correction which must be applied to eliminate the vibration of the work at its bearings.

The amount and location of unbalance indications are not affected by vibrations from adjacent machinery or other external sources. The effects of external vibrations are eliminated electrically, and only the vibrations due to unbalance which occur once per revolution of the work are recorded.

How the Unbalance Is Measured and Located

The only controls used in measuring and locating unbalance in the type of work for which the Type 3U machine has already been set up are shown by letters in Fig. 1, as follows: *A*, a hand wheel on the front of the cabinet, which is used in determining the angular position of the unbalance; *B*, two weighing dials, one of which weighs the correction to be applied on the left end of the work and the other weighs the correction to be applied on the right end of the work; *C* a switch marked "left-right" for determining in which of two correction planes the unbalance is to be measured and located; *D* a switch marked "angle-amount" for selecting whether the amount of the unbalance or its angular location is to be determined; *E* a switch for setting the meter to indicate large or small amounts of unbalance; *F* and *G* graduated dials.

To balance a part for which the machine has already been set up, the work is loaded into suitable half bearings carried in the work-supporting structure. The flexible driving connection with the hinged clamps is attached to the work. The "start" button is then pushed to bring the work piece up to speed and, after an automatically timed interval, the supporting structure, which is electrically locked during the loading time, is released to allow the work to be moved by force of unbalance.

Switch *C* is moved to "Left" and switch *D* to "Angle" positions and hand-wheel *A* is turned until the meter reads zero. The pointer on the forward angularly graduated dial *F* then shows the angular location of the unbalance in the *left* end of the work. Switch *D* is then thrown to "Amount" position and the left weighing dial *B* is turned until the meter reads zero. This dial setting then registers the amount of correction required in the desired practical correction units. The switches are then

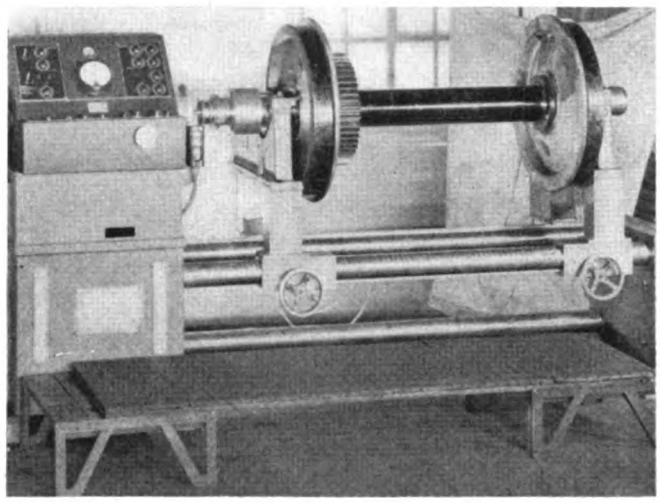


Fig. 2—Determining the static and dynamic unbalance in a pair of mounted traction wheels

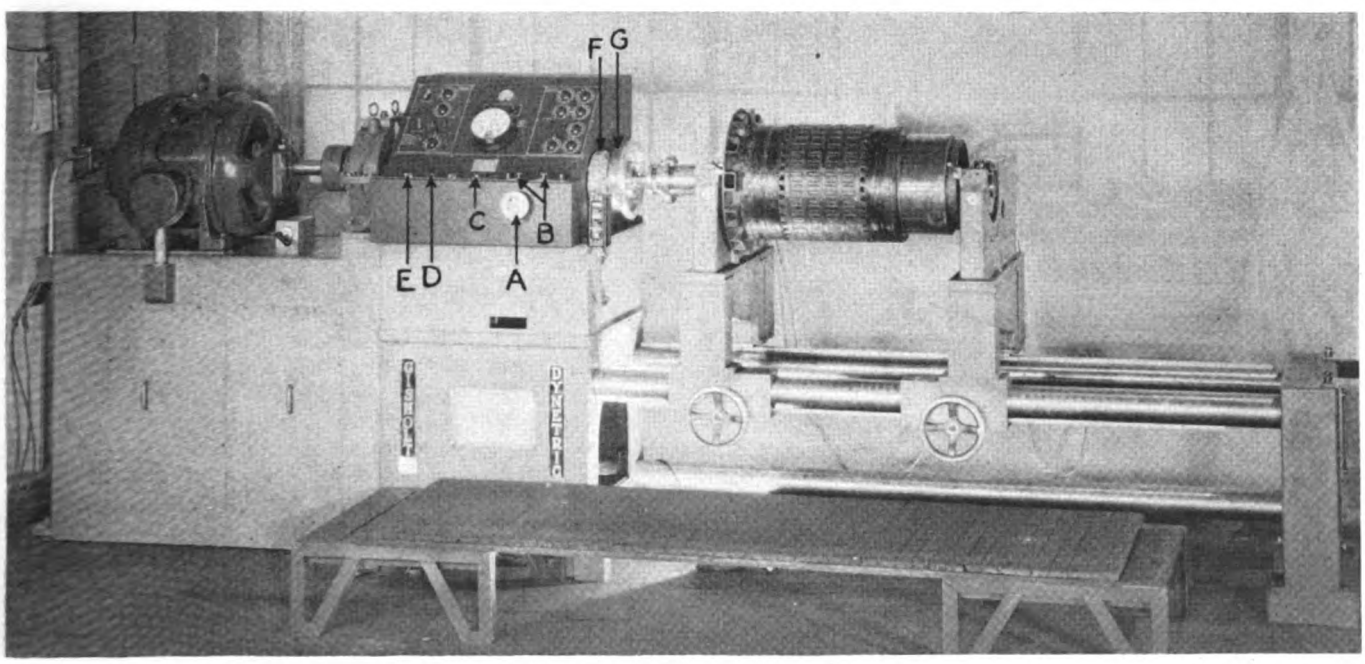


Fig. 1—Gisholt Type 3U Dynetric balancing machine being used to balance a traction-motor armature

set to "Right" and "Angle" positions and the handwheel is again turned until the meter reads zero at which time the angular location of the unbalance in the *right* correction plane will be indicated on the forward angularly graduated dial. Switch *D* is then set at "Amount" and the right weighing dial is turned so as to give zero meter reading. The dial setting will then register the amount of correction required in the *right* end of the work. The stop button may now be pushed to bring the work to rest by a magnetic brake on the motor shaft and to lock the work-supporting structure. The measuring operations can easily be completed in 20 seconds.

Now, if the "inch" button is pushed, the work can be inched around until the rear angularly graduated dial

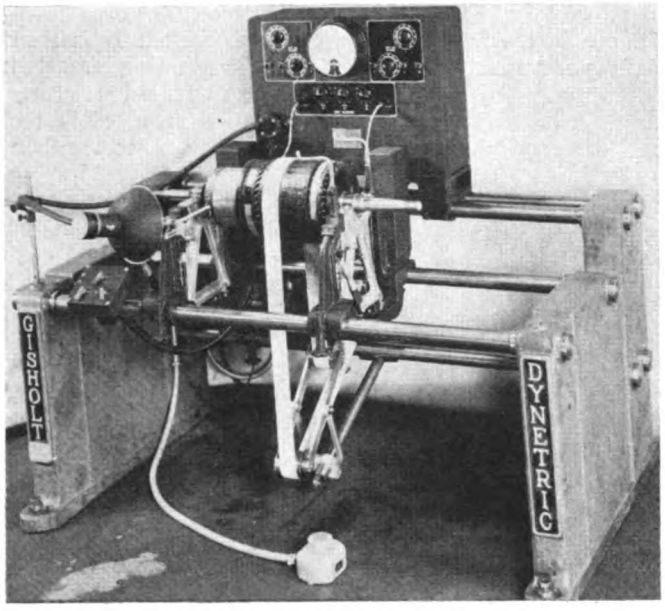


Fig. 3—Gisholt Type 3S Dynetric balancer used in balancing armatures and fans for Pullman car service

G indicates "Left Angle" as read above and the index pointer on the left work support will point out the location of the unbalance correction. Then, if the work is inched to "Right Angle" position, the index pointer on the right work support will indicate the location of the right end unbalance correction. When the correction locations are properly marked, the work may be removed from the machine to apply the correction and the unbalance may be measured and located in another part.

The dials and switches on the sloping surface of the cabinet are used only for setting up the machine to indicate truly unbalance in known practical correction units in planes of correction suitable for the work piece and at correction radii permitted by the work piece. Once these dials and switch settings have been determined and recorded for a given type of piece only a minute is required to return them to the recorded settings when that type of piece is again to be balanced. Less than 15 minutes is necessary to determine and record these dial and switch positions for a new type of work piece.

The procedure to be followed in setting these dials and switches for the first of a new type of piece is inscribed on the sloping surface of the cabinet, and as all dials and switches are numbered to suit the instructions, it is said that even an inexperienced operator can easily make the required setup.

The purpose of each dial and switch on the sloping surface of the control cabinet may be readily understood by referring to Fig. 1. The switch in the upper left corner permits of selecting the degree of machine sensitivity required. The other switch on the left side of the cabinet cuts in or out the compensating generators. These compensating generators are running only during the setting up and provide a means whereby voltages may be introduced into each of the pick-ups attached to bearing supports to nullify the effect of voltages being generated in the pick-ups due to vibrations of the work supports produced by the rotation of the unbalanced part. This brings about a condition of electrical balance and the meter will give no reading. The four dials on the right side of the cabinet permit of adjusting the compensating generator voltages to give this condition of electrical balance.

The remaining dials and switches are in two duplicate rows, one on either side of the meter. The row on the left of the meter is used for setting up to indicate unbalance in the left plane and the row on the right of the meter is used for setting up to indicate the unbalance in the right plane. The upper dials in the two rows permit of making the meter read in practical units of correction (different units for each end of the piece if desired).

The second dial in the row is the adjustment on the lever or voltage divider. The switches immediately below these dials permit of getting the proper out-of-phase relationship of the voltages for all conditions.

The remaining dial in each row permits of calibrating the "Right" and "Left" weighing dials so that they will read in desired correction units such as 0.010 ounce, 0.0156 in. of depth of a given size of drill, 0.01567 in.

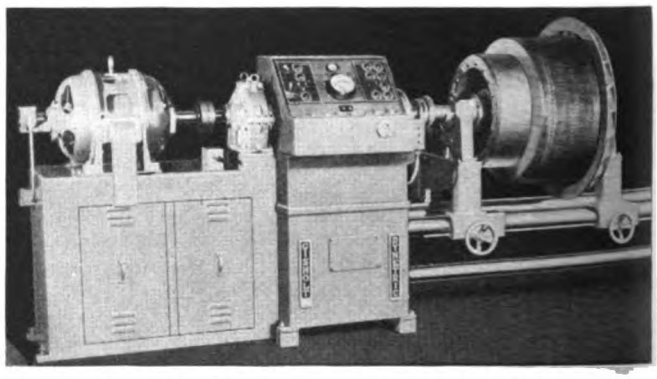


Fig. 4—Type 3U machine being used to balance a Diesel-locomotive generator armature 56 in. in diameter and weighing 5,300 lb.

of length of bar stock of known size, etc. These corrections are applied in planes of correction permitted by the construction of the work piece and at predetermined radii in each of the correction planes.

The Type 3S Dynetric balancer, illustrated in Fig. 3, is one of the smaller machines used in balancing armatures and fans for Pullman car service and will take 24-in. by 24-in. work, weighing up to 200 lb. In regular production with this machine, the time for measuring and locating unbalance is less than 30 seconds and repeat parts can be set up in about 10 min. The machine operates on the same general principle as that already described, except that the work is belt-driven and angular location of the unbalance is determined by a separately mounted Stroboglow lamp. D. c. armatures, such as that illustrated, are often corrected for unbalance by adding solder to the bonding wires at points indicated by the balancing machine.

Other Gisholt Dynetric balancers include the Type C machine for balancing parts such as crankshafts and the Type E static balancer for parts such as small flywheels, fans, pulleys, etc., in which the diameter of the piece greatly exceeds its thickness.

Canadian National Method For Lagging Application

The photographs and drawing accompanying this article show a method of applying block lagging to locomotive boilers developed by the Canadian National at the Pt. St. Charles Shops, Montreal, Que. which has the advantages of ease of application and permanence with respect to the fixtures used.

The general arrangement is shown in Fig. 1. The lagging is held by "brackets" formed by punching and bending strips of jacket steel 3⅞-in. wide and of a length to suit the diameter of the boiler course on which they are to be used. The dimensions of the openings in the finished strap and the manner of making the bends is shown in the drawing in Fig. 2 and in the photographs in Figs. 3 and 4. The completed straps are supported at the top end, on the boiler, by a ¼-in. lip over the edge of a ¼-in. x 1¼-in. flat bar which is supported in turn by the handrail post studs. There is, at each opening in the strap and at the top near the flat-bar support, a bent portion which holds the strap and the lagging 5/16 in. away from the boiler sheets.

On the average boiler there are about 25 lagging straps to each side of a barrel and firebox. These are spaced about 18 in. apart. The straps for the barrel courses are made in lengths to suit the application and will hold, for example, from 16 to 18 ordinary size blocks of lagging in the length from the flat bar support to the bottom center line of the barrel courses. The firebox straps are short ones which may hold only six or eight blocks. These straps are not fastened at the bottom.

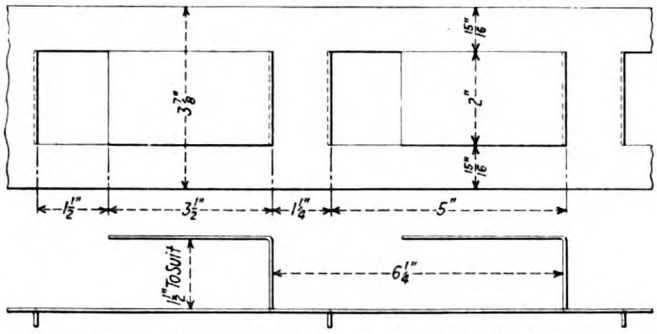


Fig. 2—Dimensions of the strap and the brackets

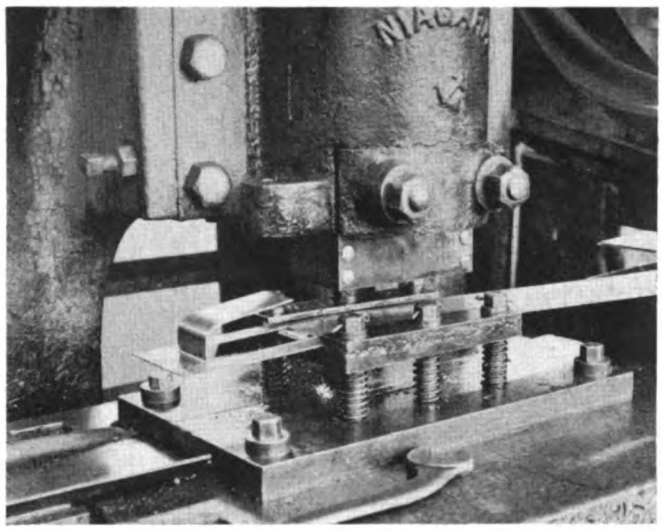


Fig. 3—Close-up of the die for punching the straps

The barrel-course straps are fitted with clips where the two straps are held together at the bottom center line. The two straps are drawn together by means of ⅜-in. bolts. The straps are made in the shops in a No. 6 Niagara punch in which a special spring die is used. Fig. 3 shows the die in the open position after having punched and bent a "bracket" opening in the steel strip. Fig. 4 shows a section of a strap with five brackets. This photograph shows the 5/16-in. leg on the back of the strap which holds the lagging away from the boiler.

This device and its method of application is protected by Canadian and U. S. patent application.

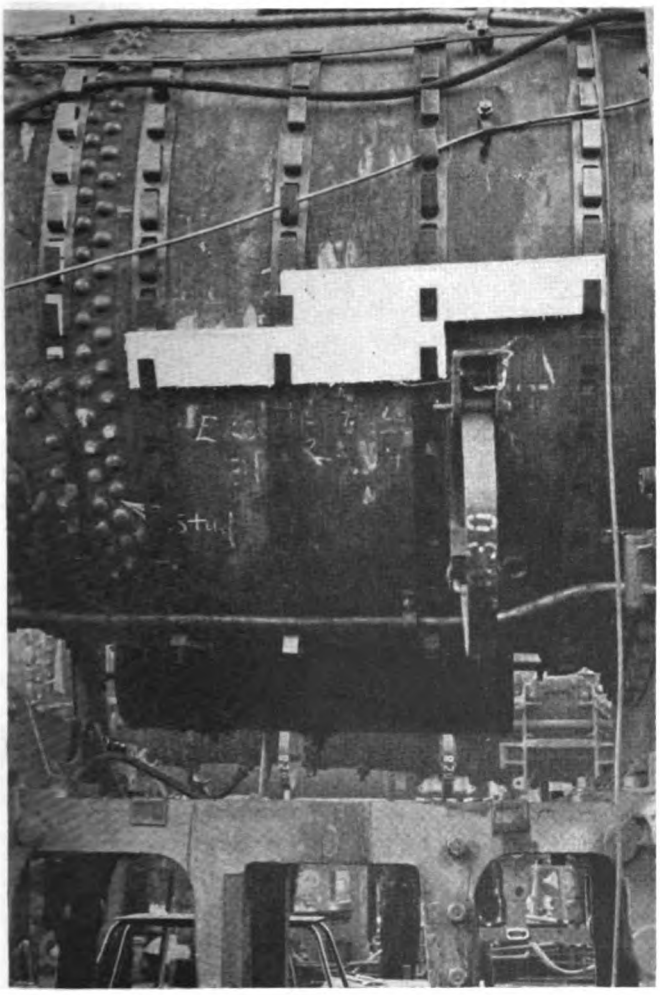


Fig. 1—General arrangement of the lagging straps on the barrel of the boiler with two blocks in position to show how they are held

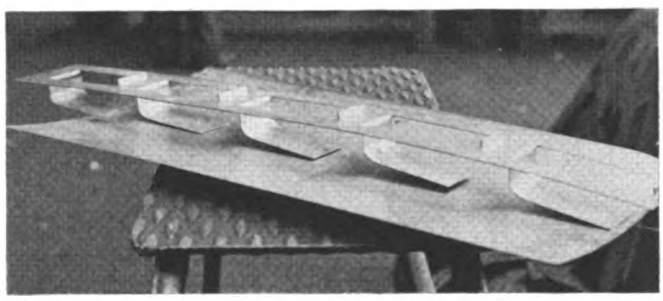


Fig. 4—A section of a strap after the punching operation showing spacer legs on back of strap

Water Rheostat for Testing Diesel Locomotives

*By C. C. Whittaker**

A simple, "home-made" rheostat can be built that greatly facilitates the testing of Diesel-powered locomotives. Such a rheostat is inexpensive to build, and yet affords maintenance men the opportunity of conveniently and accurately testing new or overhauled engines under various loads. It can be made almost entirely of parts which are available in any railroad shop.

Most liquid rheostats have used various salts dissolved in water to form electrolytes, such as sodium chloride, (NaCl) and sodium carbonate (Na_2CO_3), the latter giving more satisfactory results because of less corrosion on the steel parts wet with the electrolyte. Because this electrolyte gets hot it is frequently necessary to add cold water and more salt to bring the temperature and conductivity of the electrolyte within operating limits. This procedure is inconvenient and causes loss of time.

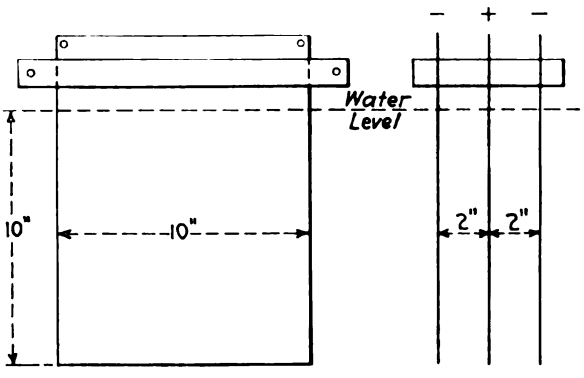


Fig. 1—Test rig for determining water resistance

The rheostat described here does not need salt of any kind, but employs tap water just as it comes from the water system. Water is permitted to flow through the rheostat continuously while the test is in progress, the amount of water being varied to suit the load. Approximately 34 gallons of water per minute will carry off the heat generated by the output of 1,000 engine horsepower, assuming 93 per cent generator efficiency and 5 per cent loss for auxiliaries.

The specific resistance of tap water differs considerably in different localities. This can be compensated for in a large measure by making the rheostat of such a size that it will match the resistance of the water.

The first step in building a rheostat should, therefore, be to determine the specific resistance of the water that will be used. This can be done by means of three pieces of sheet iron 10 in. wide, 12 in. long and of any convenient thickness. All oil and grease should be removed from the plates with soap and hot water before assembly. The sheets are then spaced 2 in. apart by wood strips and clamped together by two bolts, as shown in Fig. 1. This test rig, when immersed in water so that 10 in. of the plates are below water level, will then have 100 sq. in. on each side of the positive plate, each square inch acting through 2 in. of path to a negative plate. A wood box or a steel tank may be used providing the plates are 5 in. or more away from the tank.

The resistance of the water is determined by applying 500 or 600 volts d.c. to the electrodes and measuring both voltage and current. The locomotive generator may be used for this purpose if no other source is available. The resistance of the water will be R = E/I. Since there are 200 sq. in. of area, each with a 2-in. length of path, one cubic inch of water will have a resistance of 200 R/2. Readings during the above test should be taken with the sample water at approximately 30-deg. C., since the resistance decreases as the temperature rises, 90-deg. C. water having approximately half the resistance of water at 30-deg. C.

While the readings are being taken, the water should be agitated by a wood paddle or by having water flow past the electrodes to minimize the effect of polarization.

Having determined the resistance of a cubic inch of local water, reference should now be had to the table which gives required dimensions of rheostats, built as shown in Figs. 2 and 3.

Obviously, a rheostat could be designed with such a large plate area and low current density that the plates would last indefinitely. However, the first cost and size of such a device would be prohibitive, especially for the railroad which requires only an occasional test of this kind. Accordingly, the dimensions of the design have been reduced to permit low first cost and sufficient life for railroad application.

Wherever direct current is passed through a liquid rheostat, the positive electrode is chemically decomposed over a period of time, the rate increasing with the current density of the electrodes. In the design given, the estimated life of the electrode required by 800-ohm water is 200 hours at maximum rating. A great deal of the

* Railway engineering department, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

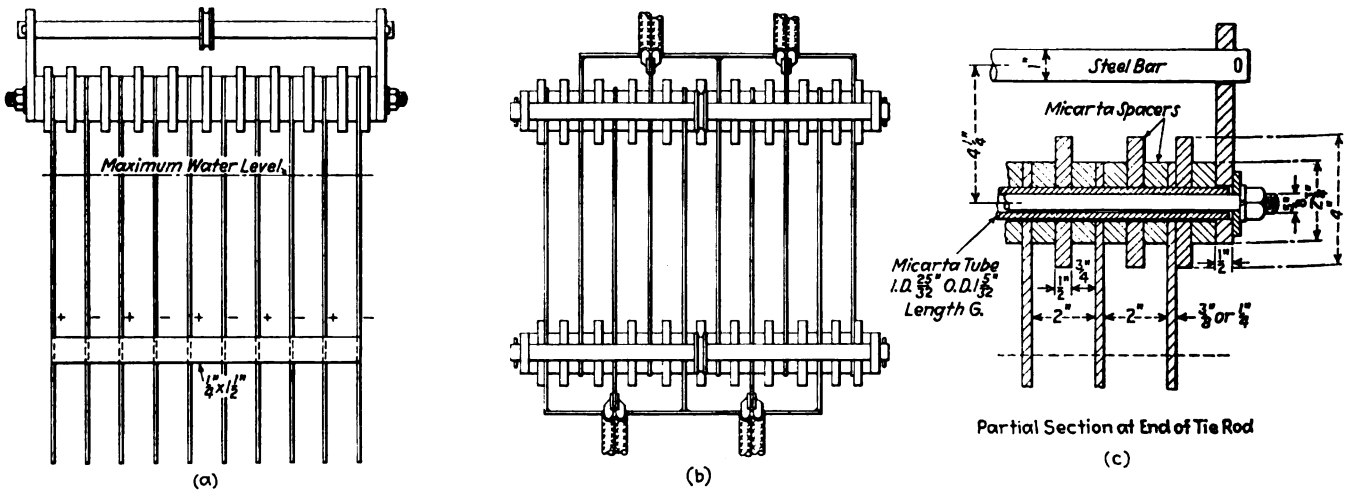


Fig. 2—Plate assemblies for the completed rheostat

testing will be done at less than full load rating so that the actual time of disintegration should be much longer than this. Frequent reversal of plate polarity should be made to wear out both electrodes uniformly. The electrodes can be made of ordinary boiler plate steel.

The Micarta insulating spacers should be dipped in Alkyd resin varnish, before being assembled, and allowed to become dry enough to handle. When assembled in this condition, and the tie rod nuts drawn up tightly, the plastic varnish coat will yield enough to make well-sealed joints between all adjacent surfaces. After the assembly is complete, all insulating washers should be given two coats of this varnish.

At full load, the electrodes must carry approximately 1,000 amperes and the cables must be sufficiently flexible to permit movement of the electrodes. It is therefore desirable to divide this current between four cables for each polarity, using 600-volt cable having 259 strands of 0.0254-in. diameter wire, the cable having a bare diameter of 0.533 in. and an overall diameter of 0.841 in. The four cables are held in split wood cleats as shown in Fig. 3.

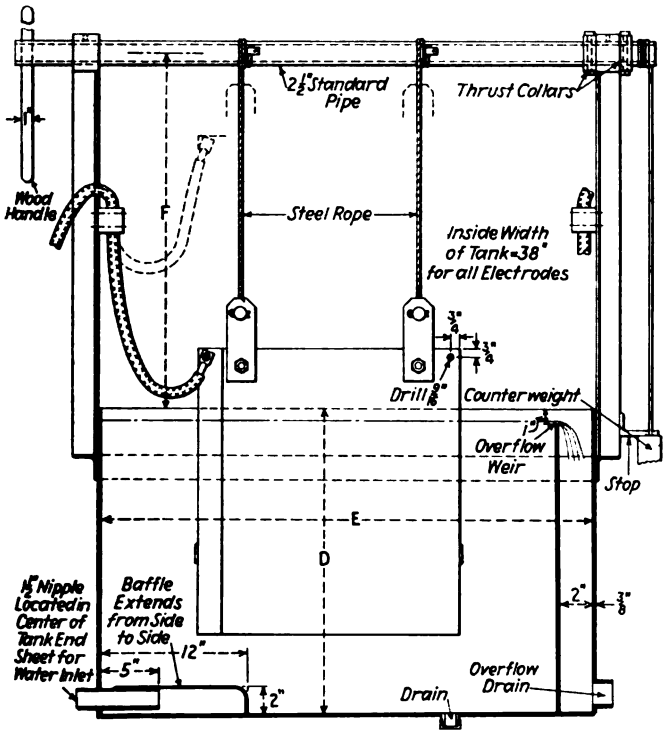


Fig. 3—The complete rheostat showing hoisting mechanism, tank and water connections

Adjustment of the height of the electrodes in the water can readily be made by hand by turning the supporting pipe by means of the wood handle. With the electrode counterweighted, there should be enough friction in the bearings to hold any given adjustment. If remote control is desired, it is a simple matter to attach a motor and gear reduction unit to the shaft.

In order to make the test set safe for operators, the tank should be grounded. This can most easily be done through the water inlet pipe.

In localities where the water is so pure that the resistance is too high to be used without excessive plate areas, the largest design shown can be used and the low conductivity of the water supplemented by the addition of sodium carbonate as found necessary. If this is done, the feature of being able to operate continuously is lost and it will be necessary to stop at intervals to replenish the electrolyte.

Dimensions of Plates and Tank (Figs. 2 and 3)

Ohms per cu. in. of water by test	Plate Dimensions: Width, in. *A*	Height, in. *B*	Thickness, in. *C*	Tank Dimensions: Depth, in. *D*	Length, in. *E*	Distance, top of tank to center of hoist shaft, in. *F*	Length of Micarta insulator, in. *G*
500	24	15	0.375	28	33	30	25.2
600	24	18	0.375	28	36	30	25.2
800	24	24	0.375	28	42	30	25.2
1,000	24	30	0.375	28	48	30	25.2
1,200	24	36	0.375	28	54	34	25.2
1,500	28	36	0.375	32	54	34	25.2
2,000	36	36	0.25	40	54	42	23.9
2,500	36	45	0.25	40	63	42	23.9

While the rheostat is in operation bubbles of hydrogen and oxygen will be given off. The oxygen will unite with iron electrons forming ferrous and ferric oxide. This will appear as a brown froth and will be carried over the overflow. Because of the liberation of oxygen and hydrogen, the rheostat should be located in a well ventilated space. If located out of doors, the insulated tie rod assemblies should be protected from the weather when not in use and should be given a coat of varnish if their surface shows a dry appearance.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Testing and Repairing Steam Gage

Q.—How are steam gages tested? If gages are found to show an incorrect reading, how are they fixed? Where is the steam gage connection on a locomotive boiler located?—M. I. D.

A.—The I. C. C. Laws, Rules and Instructions for Inspection and Testing of Steam Locomotives and Tenders and their Appurtenances, provides as follows:

Time of testing:—Steam gages shall be tested at least once every three months and also when any irregularity is reported.

Method of testing:—Steam gages shall be compared with an accurate test gage or dead-weight tester and gages found inaccurate shall be corrected before being put into service.

The method of adjusting a steam gage depends upon the trouble experienced and upon the accuracy desired. If, upon testing, the gage is found to be out a definite number of pounds and this discrepancy is about constant throughout the entire scale, the resetting of the hand is all that is necessary. This is accomplished by removing the gage hand with a gage-hand puller and then refiitting it to the spindle by very light hammer blows at the proper setting.

However, should there be found to be a progressive gain or loss, an adjustment in the mechanism has to be made. This adjustment, of course, is more troublesome except to an expert. Most manufacturers recommend

the gages be returned to the factory for repairs except where the user maintains a department that can properly repair and recalibrate gages.

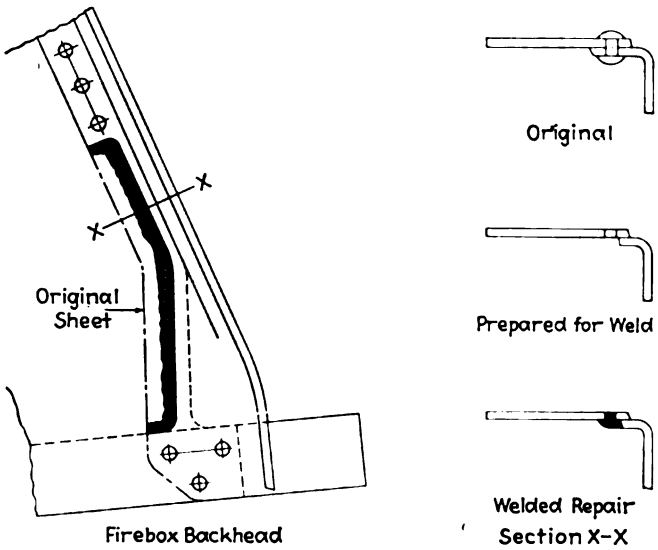
The steam gage connection in the boiler is generally located at the top of the boiler, usually in the corner radius of the backhead.

Checked and Cracked Rivet Holes in Door Sheet

Q.—We have considerable trouble with the checking and cracking of rivet holes in the firebox door sheet at the firebox corners. How can this condition be repaired?—K.F.R.

A.—There are various methods of repairing the condition outlined in the question. Although the manner of repair generally depends upon the conditions as found in each specific case, the diagram illustrates a typical repair to overcome this condition.

The door sheet is cut back far enough to eliminate the existing rivet holes, after which the sheet is bevelled to 45 deg. and properly cleaned for welding. The seam is then lap welded as shown, completely filling the old rivet holes in the firebox and sheet.



A typical method of repairing checked and cracked rivet holes in the door sheet

The Design and Application of Stoker Tubes

Q.—How is the thickness of the stoker tube in a locomotive boiler determined, that is, the tube in the boiler backhead for the stoker distributor of a Duplex stoker. The boiler pressure is 250 lb. per sq. in. How are these tubes applied?—J. E. R.

A.—The 1937 A. S. M. E. Boiler Construction Code, Par. P-22, gives the following formulae for computing the maximum allowable working pressure for steel or wrought-iron tubes or flues for fire tube boilers for different diameters and gages of tubes as follows:

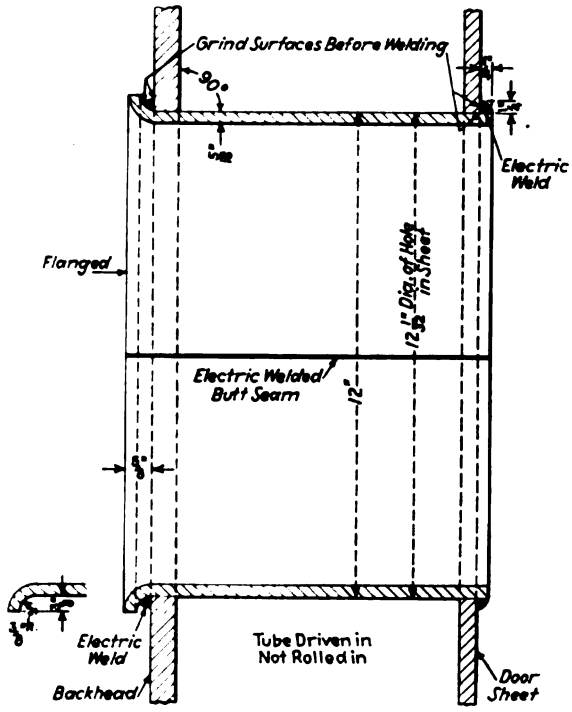
$$P = \frac{(t - 0.065)}{D} \times 14{,}000$$

where

P = maximum allowable working pressure, lb. per sq. in.
t = minimum wall thickness, in.
D = outside diameter of tube, in.

transposing we have

$$t = \frac{DP}{14{,}000} + 0.065$$



Typical stoker-tube application to the back head

Stoker tubes for Duplex stokers usually have a 12-in. outside diameter. Substituting in the formulae the values $D = 12$ and $P = 250$ we have

$$t = \frac{250 \times 12}{14{,}000} + 0.065$$

$$t = .2142 + 0.065$$

$t = .2792$ in. or 5/16 in. thick.

A typical application of a stoker tube to the backhead of a locomotive is shown in the illustration.

Rivets Required to Hold Brace Rods

Q.—A locomotive boiler backhead is supported with three 1½-in. brace rods. The brace-rod connection to the backhead consists of a 6-in. by 4½-in. T-iron. What would be the number and size of rivets required to secure the T-iron to the backhead?—K. I. M.

A.—Rule No. 3(a) of the I. C. C. Laws, Rules and Instructions for Inspecting and Testing of Locomotives, provides as follows, "The maximum allowable stress per square inch of net cross-sectional area on round, rectangular, or gusset braces shall be 9,000 lb.

The net cross-sectional area of a brace 1½ in. in diameter equals 1.7671 sq. in. The effective cross-sectional area of each brace rod must be determined by taking the angle of each brace rod, and, if in excess of 15 deg., the area of the brace must be reduced by multiplying the area of the brace by the cosine of the angle that the brace makes with a line drawn at right angles to the area supported.

Assuming, for example, that the top brace has an angle of 12 deg., the middle brace an angle of 20 deg., and the bottom brace an angle of 30 deg., then the effective cross-sectional area of the braces would be:

Top brace	1.7671
Middle brace = 1.7671 × .93969 =	1.6605
Bottom brace = 1.7671 × .86602 =	1.5303
Total effective cross-sectional area	4.9579 sq. in.

Maximum permissible load on braces = 4.9579 × 9,000 = 44,621 lb.

It is the practice to use 7/8-in. rivets for securing 6-in. by 4½-in. T-irons to the backhead. Assuming 50,000

lb. per sq. in. for the tensile strength of steel rivets and a factor of safety of 4, the allowable load on the rivets would be 12,500 lb. per sq. in.

Required cross-sectional area of rivets =
44,621 ÷ 12,500 = 3.5696 sq. in.

In computing brace-rod connections, it is the practice to make the brace-rod jaws, eyes, brace feet, pins, rivets and angle irons stronger than the body of the brace.

The A. S. M. E. Code makes the following provisions:

Par. P-223 (8) Make the combined cross-sectional area of the rivets at each end of the brace at least 1¼ times the "required cross-sectional area" of the brace.

Required cross-sectional area of rivets =
3.5696 × 1.25 = 4.462 sq. in.

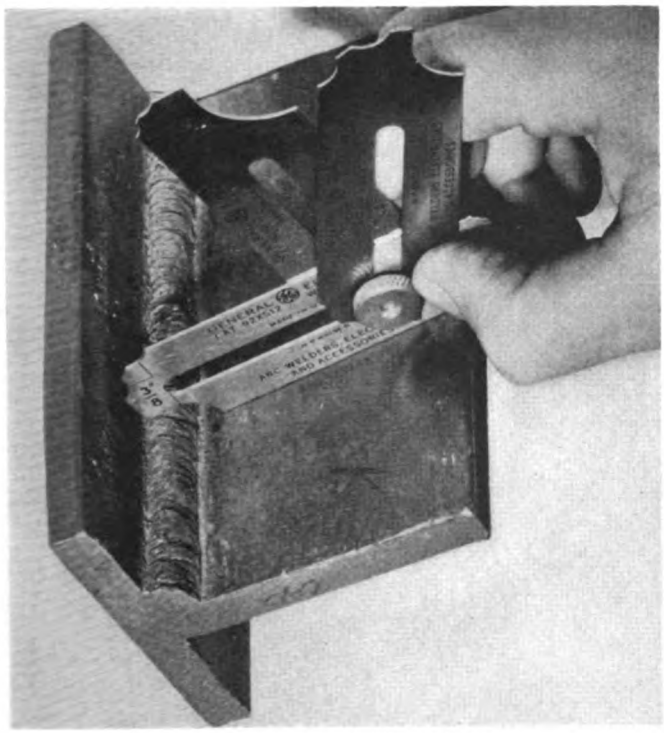
The cross-sectional area of a ⅞-in. rivet after driving would be the cross-sectional area of a $^{15}/_{16}$-in. diameter rivet hole or .69029 sq. in.

Number of rivets required = 4.462 ÷ .69029 = 6.46

The actual number of rivets to be used in this case would be 8.

Gage for Checking Fillet-Weld Size

A fillet-weld gage has been developed by the General Electric Company, Schenectady, N. Y., to meet a need of welding inspectors and operators for a fast, accurate



The General Electric fillet-weld gage

means of checking the size of fillet welds on work which has to meet rigid specifications.

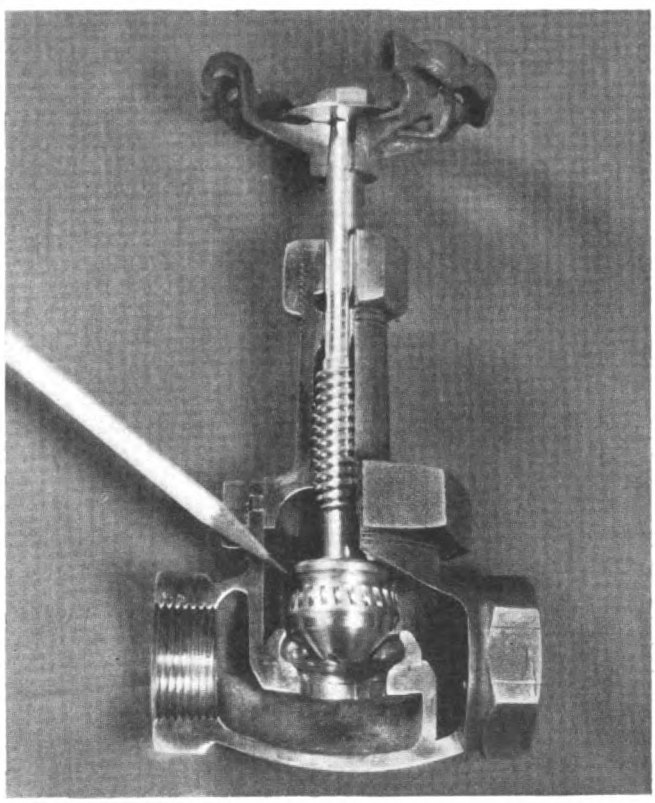
The gage consists of three stainless-steel stampings held together by a bolt and knurled thumb nut. Either convex, concave or standard fillets can be checked merely by fitting the edge of the gage flush against the work so that the indicating portion of the gage rests on the weld bead. The gage can be used to check fillets of the following sizes: ¼ in., $^5/_{16}$ in., ⅜ in., $^7/_{16}$ in., ½ in. and ⅝ in. These sizes are clearly marked in black on the gage.

Steam Valve With A Spinning Disc

The Ostlind valve is designed to eliminate rather than resist the causes of leaky valves. The outstanding feature of this valve is a spinning disc which rotates at speeds up to 2,000 r. p. m. for a moment preceding closing. The spinning disc throws off scale and other foreign particles by centrifugal force, thereby preventing these particles from becoming caught in the line of seating. The disc hits the seat while spinning at a high rate of speed and consequently polishes the line of closure, creating a complete metal-to-metal contact between the seat and the disc. The disc does not spin when the valve is in the cracked position or while throttling the steam. A reversing chamber directs the steam flow to the turbine vanes just before the disc descends on to the seat. These vanes are shielded from the steam flow when the valve is open.

The valve is equipped with two separate seats, one for closing and one for cracking and throttling, in order that the line of closure may be protected from the erosive action of high-velocity steam and to prevent scale from sticking to it during operation. When the valve is opened one full turn from the closed position, it will be cracked from the throttling seat. If the valve is opened more than one turn throttling is effected between the side of the disc and the throttling seat. The valve is shown in the throttling position in the illustration. Further opening of the valve brings it into full open position.

The disc is mounted on the spindle against a stainless-steel ball bearing which aligns the disc with the seat when closing. The bearing will stand a temperature of 950 deg. F. and maintain a hardness of 60 Rockwell C. The valves are built in sizes from ½-in up by Ostlind Valve Inc., Portland, Ore.



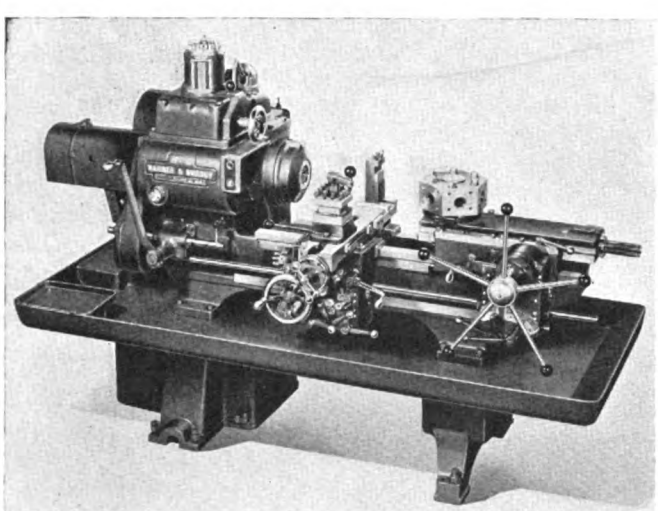
The Ostlind valve has a disc that spins at speeds up to 2,000 r.p.m. just before closure

Ram-Type Turret Lathe

A more rigid bed design, a head brake, and improved head lubrication are some of the improvements made in the new No. 4 ram-type turret lathe, developed by the Warner & Swasey Co., Cleveland, Ohio. It has a bar capacity of two inches, which is ¼-in. greater than the capacity of the No. 4 machine it replaces, and an 18⅛-in. chucking swing.

This turret lathe is equipped with the pre-selector head only, signalling the definite establishment of the pre-selector as an easily-operated, time-saving unit for reducing costs. Heretofore, the pre-selector head was available as optional equipment. With this unit only one lever is required to shift the gears and cutting operations are placed on a surface-feet-per-minute basis which materially simplifies the operation of the lathe. To further ease the shifting of the gears the location of the shifter fork was changed from the outside diameter of the gear teeth to a hub on the shaft.

To maintain accuracy during extreme cutting conditions the rigidity of the bed has been increased almost 30 per cent by a new design that features diagonal ribbing, similar to bridge truss bracing, instead of the conventional box-type ribbing. This construction also increases considerably the clearance space for chips as they fall into the pan, a matter of increasing importance as the rate at which metal is removed is increased.



The Warner & Swasey No. 4 ram-type turret lathe

The head of the machine is lubricated by a forced-feed system. With oil stored in a reservoir in the base of the machine, the lubricant is kept considerably cooler than it is in the splash system. The spindle brake, another new feature, is an improved type that can be released after the spindle is stopped to allow the positioning of chucks and fixtures.

There are six reversible power feeds, both cross and longitudinal, for the universal cross slide and the speeds increase uniformly to provide a proper range for all classes of work. The square turret indexes automatically, and the large cross-slide dial has widely-spaced graduations for accurately measuring the depth of the cut. A plunger oil pump on the cross slide thoroughly lubricates both the cross slide and the bed bearings. The hexagon turret is equipped with adjustable stops for automatically tripping the feed for each turret face, and the turret may be indexed in either direction to skip tool stations. Adjustable taper gibs at the side and top of the turret slide assure the proper fit under all conditions. The hexagon turret revolves on an adjustable tapered roller-bearing center stud and under the slide are hardened replaceable plates.

The motor and drive are completely enclosed in a cabinet leg directly under the head end of the machine which has doors on either side to permit ready access to the motor. Multiple V-belt equipment is furnished.

Tool Opens Flanges For the Renewal of Gaskets

Flange-Jacks are tools designed to open flanges on existing pipe lines for the renewal of gaskets. Using this tool, the flanged joints are opened quickly without damage to the flange faces. There will be no sparks or vibration in the pipe line as might result from hammer blows on chisels or wedges. As the jackscrews are tightened, the flanges are separated gradually and evenly.

To replace gaskets, two bolts are first removed from the flanges. The jaws of a jack are placed in each of these bolt holes and the screws are tightened just enough to hold the jacks in position. The remainder of the bolts are then removed, after which the jackscrews of both jacks are tightened down at the same time so the flanges will separate evenly. When a sufficient opening has been obtained, the old gasket may be removed and a new gasket applied.

Flange-Jacks have jaws of one-piece steel forgings and steel screws, the points of which are case hardened. In laboratory tests this tool has opened joints against a load of 15 tons without damage to the jacks or the flanges. They are always used in pairs and are available in three sizes for opening up to 48-in. standard flanges and 30-in. extra heavy flanges. These tools are a product of the Garlock Packing Company, Palmyra, N. Y.



The flanges are being separated by Flange-Jacks

High Spots in

Railway Affairs . . .

Railroad Safety Records Broken

The Interstate Commerce Commission first began to compile records in 1888. Statistics just released indicate that in the year 1939 fewer passengers suffered fatalities in railroad accidents than in any year since the Commission began making such reports. Thirteen persons lost their lives in train accidents in 1939, nine of these occurring in one accident which the report of the Interstate Commerce Commission ascribed to sabotage. Fourteen passengers were fatally injured in train service accidents in 1939, these accidents consisting for the most part of mishaps in getting on and off moving trains.

Predict Increase in Freight-Car Loadings

The reports of the thirteen Shippers' Advisory Boards indicate that the freight-car loadings in the second quarter of this year will be about 18.1 per cent above those for the same period last year. These estimates cover the 29 principal commodities. The percentages for the different boards vary considerably. The Ohio Valley Board estimates an increase of 74.9 per cent, and is followed by the Allegheny with 57 per cent, the Northwest board with 26.4 per cent, the Pacific Coast board with 14.9 per cent, and the Great Lakes board with 10.1 per cent. From this they taper down, but only one board, the Southwest, estimates a decrease, amounting in that case to 4.4 per cent.

Conferees Still At Work on S. 2009

The conferees on the Omnibus Transportation Bill, S. 2009, suspended their meetings on March 23, because of the absence of Chairman Wheeler on a trip to the west coast. Secrecy has been observed as to the progress which has been made in composing the differences between the Senate and the House bills. It is believed, however, that up to the time this was written, agreement had been reached on practically all matters except the Harrington "labor protection" amendment. Since separate bills on forwarder regulation have recently been introduced in both houses, it seems apparent that this phase of the problem has been dropped from consideration in the omnibus bill. The best guess seems to be that the conference report will hardly be presented to Congress before the latter part of this month.

Railway Purchases Last Year

The railroads, even under unfavorable economic conditions, are heavy buyers—measured in dollar terms—of supplies and equipment. Last year, for instance, their purchases passed the billion dollar mark. According to the Railway Age, Class I roads purchased $770,373,361 of materials, supplies and fuel, exclusive of equipment. For these same items the short lines and switching and terminal companies, not controlled by Class I railroads, spent $34,752,-418. Likewise, the Pullman Company for its rail line operations expended $11,133,-599. Private car-line companies purchased $9,495,717 of materials for their rail line operations. Orders for new locomotives and cars from the equipment builders amounted to $188,839,000.

Railway Net For First Two Months

According to the Bureau of Railway Economics of the Association of American Railroads, the net railway operating income for Class I railroads in the United States for the first two months of 1940 was $78,373,416; this is at the annual rate of return of 2.78 on their property investment. During the first two months of 1938 the rate of return was 1.83 per cent, while during the first two months of 1930, ten years ago, it was 3.79 per cent on property investment. It is of interest to note that the taxation for these two months in 1940 amounted to $61,215,733, while in 1930, when the net return was much larger, they amounted to only $57,179,390. Twenty-nine Class I roads failed to earn expenses and taxes in the first two months of 1940.

Frank Talk About the Waterways

United States Senator Bailey, a Democrat from North Carolina and chairman of the Senate Commerce Committee, certainly made a frank statement, when in speaking before the National Rivers and Harbors Congress, held at Washington last month, he indicated that a halt must be called in government spending for the improvement and maintenance of the country's rivers and harbors. Moreover, he suggested that those who use the rivers, harbors and canals should pay at least the annual upkeep of $52,000,000. He said that President Roosevelt had warned him that the time had come to cease voting large authorizations for river and harbor improvements and had urged that no bill be enacted at this session.

Fewer Fatalities At Grade Crossings

The ownership of automobiles in this country has steadily increased in recent years, from the low point in the 30's of 23,843,591 on December 31, 1933, to 29,485,680 on December 31, 1938, and naturally is still greater today. In spite of this, grade crossing accidents have been on the decrease. The railways and safety organizations have conducted spirited campaigns and undoubtedly automobile drivers have been stimulated to take greater precautions in approaching and passing over highway grade crossings. Many such crossings, particularly in critical locations, have been eliminated and there has also been an improvement in grade crossing protection. As a result there were 1,398 fatalities resulting from highway-railroad grade crossing accidents in 1939, a decrease of 119 compared with 1938, and 477 compared with 1937. In the year 1928, when such accidents reached a peak, there were 2,568 fatalities.

Pension Estimates All Wrong

The estimating of future pension liabilities is apparently an illusive sort of problem. It is much like estimating expenses for a family vacation. To be on the safe side one should lean toward the generous side in making the budget, and then should double it. In spite of the fact that most all of the early pension systems went "flooey" and that a whole crop of actuaries had to be raised and carefully nurtured, many pension systems are still giving embarrassment to those who hold the bag. According to Murray W. Latimer, chairman of the Railroad Retirement Board, it looks as if when the board completes its first four years at the end of June next year, the tax collections will have fallen from eight to ten million dollars short of the original estimates, and the board will be called upon to pay out in annuities and other benefits, about $165,000,000 more than contemplated. The principal reason? The average age of retirement has dropped from 67½ years, closer to 66, due largely, it is believed, to the reduction in business and railroad employment, as a result of which "the railroads and the men themselves try to get as many of the older men to retire as possible, and we had a real avalanche of retirements."

Among the Clubs and Associations

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.—Meeting April 16, Hotel DeSoto, St. Louis, Mo. Speaker: A. R. Ayers, general manager, New York, Chicago & St. Louis. Subject: "Transportation in Connection With the Mechanical Department." Dinner at 6:15 p.m., preceding meeting.

CAR FOREMEN'S OFFICERS ASSOCIATION OF CHICAGO.—Meeting LaSalle hotel, Monday evening, May 13. Various problems in connection with the braking of high-speed trains in both freight and passenger service will be considered. L. K. Sillcox, first vice-president, New York Air Brake Company, will address the group on Braking Trains Under Modern Conditions.

PACIFIC RAILWAY CLUB.—Meeting 7:30 p.m., April 12, Hotel Hayward, Los Angeles, Calif. Speaker: Dr. F. C. Lindvall, assistant professor of electric engineering, California Institute of Technology. Topics: (a) Air Circulating Fans in Refrigerator Cars; (b) Lightweight Passenger Cars Embodying "Above Gravity" Suspension and Skin Stressed Body Construction. Lantern slide illustrations.

EASTERN CAR FOREMAN'S ASSOCIATION.—Meeting Friday, April 12, 8 p. m., the Engineering Societies building, 29 West Thirty-Ninth street, New York. Speaker; George W. Wall, electrical foreman, D. L. & W. Topic: Air conditioning.

NEW YORK RAILROAD CLUB.—Meeting at 7:45 p. m., Thursday, April 18, at the Engineering Societies building, 29 West Thirty-Ninth street, New York. Illustrated talks on the latest developments in the art of stopping high-speed trains by C. D. Stewart, chief engineer, Westinghouse Air Brake Company, and M. N. Trainer, president, Brake Shoe and Castings Division, American Brake Shoe & Foundry Company.

NORTHWEST LOCOMOTIVE ASSOCIATION.—The Northwest Locomotive Association has been formed at St. Paul, Minn., as a medium for the exchange of information by all persons interested in locomotives or motive power. Meetings for discussion and talks will be held on the last Monday of each month except during June, July and August. Officers are: President, H. A. O'Neal, inspector of the Bureau of Locomotive Inspection of the Interstate Commerce Commission; first vice-president, C. F. Guggisberg, mechanical engineer of the Minneapolis, St. Paul & Sault Ste. Marie; second vice-president, Godfrey Lamberg, shop superintendent of the Chicago, Milwaukee, St. Paul & Pacific; third vice-president, A. G. Neese, enginehouse foreman of the Chicago, Milwaukee, St. Paul & Pacific; secretary, G. F. Greenleaf, chief clerk to the mechanical engineer of the Northern Pacific, and treasurer F. W. Taylor, general foreman of the Northern Pacific.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—Meeting May 16, 10:00 a.m., Ansley Hotel Roof Garden, Atlanta, Ga. Speaker: F. L. Huggins, general superintendent, railroad engineering division, Air Reduction Sales Co., New York. Topic: Oxyacetylene Machine Cutting in Railroad Shops.

NEW ENGLAND RAILROAD CLUB.—Meeting April 9. Address by C. H. Buford, vice-president in charge of operation and maintenance, Association of American Railroads, Washington, D. C. At the March meeting E. G. Ringberg, superintendent of shops, Boston & Maine, Concord, N. H., was elected president of the club, and D. P. Carey, assistant general mechanical superintendent NY. N.H. & H., was elected vice-president. C. H. Sherburne, treasurer, and W. E. Cade, secretary, were re-elected.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

AIR BRAKE ASSOCIATION.—R. P. Ives, Westinghouse Air Brake Company, 3400 Empire State building, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION. — J. F. Gettrust, P. O. Box 5522, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. —C. E. Davies, 29 West Thirty-ninth street, New York.
RAILROAD DIVISION.—C. L. Combes, Railway Age, 30 Church street, New York City.
MACHINE SHOP PRACTICE DIVISION.—Warner Seely, Warner & Swasey Co., 5701 Carnegie avenue, Cleveland, Ohio.
MATERIALS HANDLING DIVISION. — F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.
OIL AND GAS POWER DIVISION. — W. J. Hargest, American Machinist, 330 West Forty-second street, New York.
FUELS DIVISION. — A. R. Mumford, Consolidated Edison Co., 4 Irving Place, New York.

ASSOCIATION OF AMERICAN RAILROADS.—Charles H. Buford, vice-president operations and maintenance department, Transportation Building, Washington, D. C.
OPERATING SECTION.—J. C. Caviston, 30 Vesey street, New York.
MECHANICAL DIVISION.—V. R. Hawthorne, 59 East Van Buren street, Chicago. Meeting Stevens Hotel, Chicago, June 27 and 28.
PURCHASES AND STORES DIVISION.—W. J. Farrell, 30 Vesey street, New York.
MOTOR TRANSPORT DIVISION.—George M. Campbell, Transportation Building, Washington, D. C.

CANADIAN RAILWAY CLUB. — C. R. Crook, 4468 Oxford avenue, N. D. G., Montreal, Que. Regular meetings, second Monday of each month, except June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS. — J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, DeSoto Hotel, St. Louis, Mo.

CAR DEPARTMENT OFFICERS' ASSOCIATION.—Frank Kartheiser, chief clerk, Mechanical Dept., C. B. & Q., Chicago. Annual meeting October 22-25, Hotel Sherman, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month.

CENTRAL RAILWAY CLUB OF BUFFALO.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday of each month, except June, July and August, at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION. — Roy MacLeod, Room 127, General Office Bldg., N. Y., N. H. & H., New Haven, Conn. Regular meetings, second Friday of January, February, March, April and October at Engineering Societies Bldg., 29 West Thirty-ninth street, New York.

INDIANAPOLIS CAR INSPECTION ASSOCIATION. — R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

INTERNATIONAL RAILWAY FUEL ASSOCIATION. — See Railway Fuel and Traveling Engineers' Association.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—See Locomotive Maintenance Officers' Association.

LOCOMOTIVE MAINTENANCE OFFICERS' ASSOCIATION.—J. E. Goodwin, general foreman, locomotive department Missouri Pacific, North Little Rock, Ark. Meeting Hotel Sherman, Chicago, October 22-25.

MASTER BOILER MAKERS' ASSOCIATION. — A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y. Annual meeting October 22-25, Hotel Sherman, Chicago.

NEW ENGLAND RAILROAD CLUB. — W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Thursday in each month, except June, July, August, September and December at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION. — E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, 1931 University avenue, St. Paul.

NORTHWEST LOCOMOTIVE ASSOCIATION.—G. F. Greenleaf, chief clerk to mechanical engineer, Northern Pacific, St. Paul, Minn. Meeting last Monday of each month, except June, July and August.

PACIFIC RAILWAY CLUB. — William S. Wollner, P. O. Box 3275, San Francisco, Cal. Monthly meetings alternately in northern and southern California.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION.—T. Duff Smith, 1255 Old Colony building, Chicago. Annual meeting, October 22-25, Hotel Sherman, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION. —J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

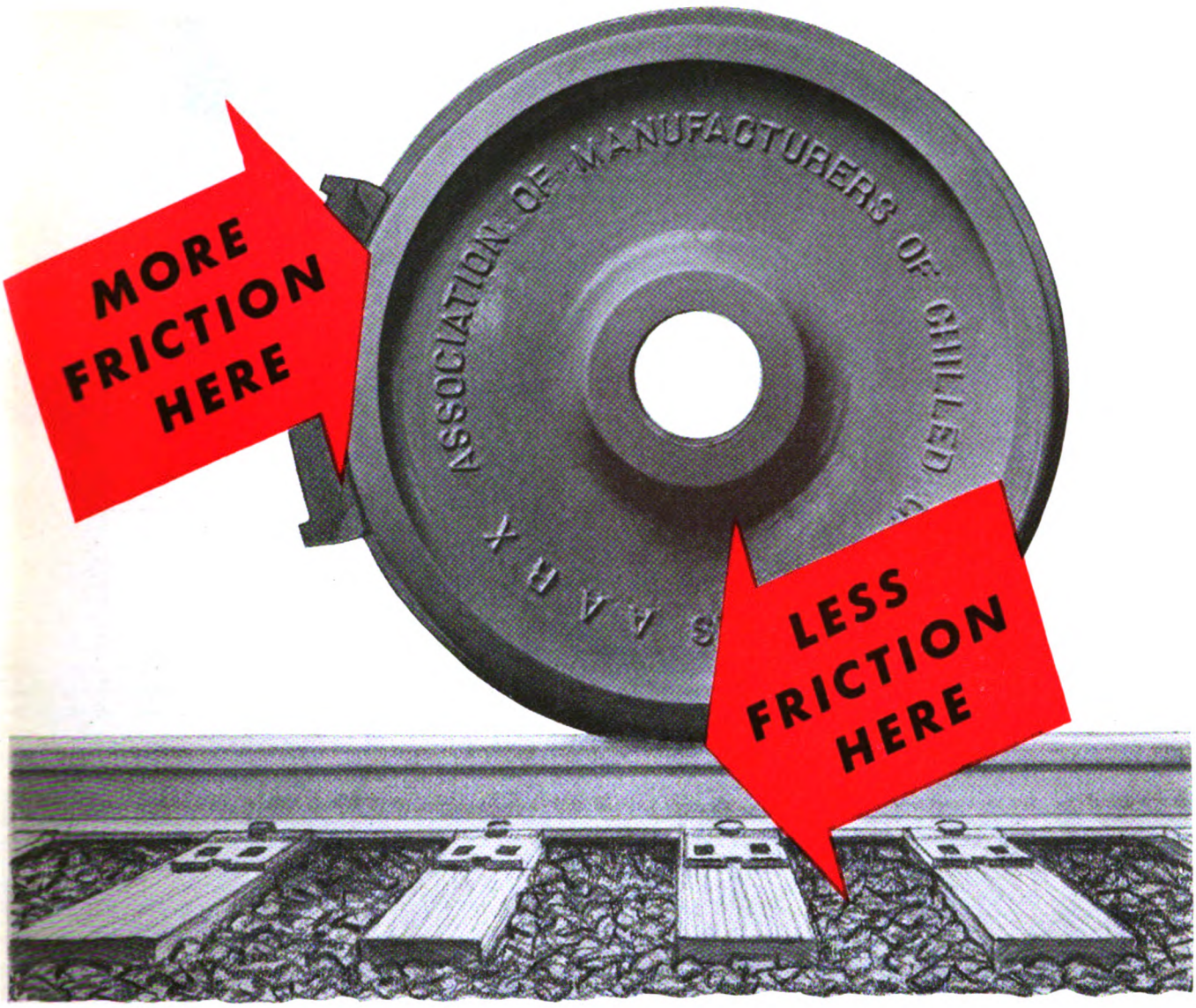
TORONTO RAILWAY CLUB.—D. M. George, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto, Ont.

TRAVELING ENGINEERS' ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

VALLEY ANTHRACITE CAR FOREMEN'S ASSOCIATION.—P. P. Kohl, executive secretary, 254 Barney street, Wilkes-Barre, Pa. Regular meetings third Monday of each month.

WESTERN RAILWAY CLUB.—W. L. Fox, executive secretary, Room 822, 310 South Michigan avenue, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

(*Turn to next left-hand page*)



The greater coefficient of friction between wheel and brake shoe which Chilled Wheels possess materially reduces strain on brake rigging and trucks, gives greater capacity to air cylinder and reservoirs and reduces stopping distance. Combine this with the materially reduced friction (adhesion) between Chilled Wheel and rail and you have two more of many reasons for Chilled Wheel economy.

4 Savings with Chilled Car Wheels:

1. Lowest cost per mile.
2. Increased rail life.
3. Increased brake shoe life.
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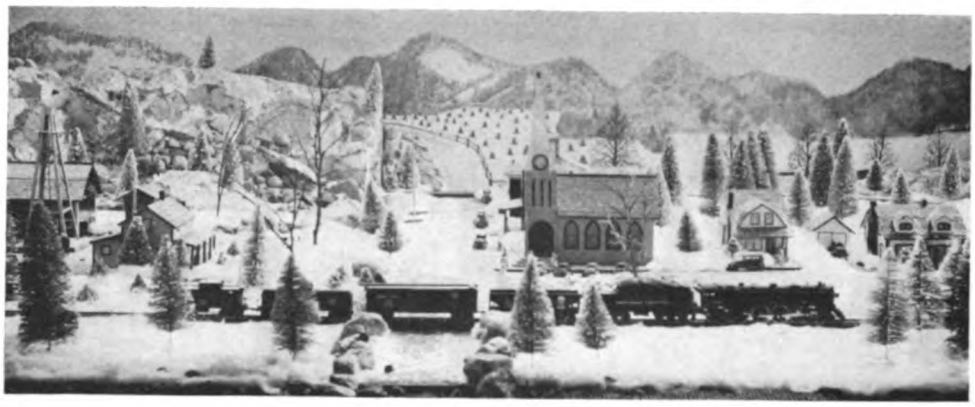
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ORGANIZED TO ACHIEVE:
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Uniform Inspection
Uniform Product



This miniature village with scenic background was built and installed in the home of A. M. Nelson, general foreman, car department, Kingsland shop, Delaware, Lackawanna & Western—The railroad is Lionel standard equipment

NEWS

Air-Conditioned Cars on January 1

CLASS I railroads and the Pullman Company had 11,715 air-conditioned passenger cars in operation on January 1, according to reports received by the Association of American Railroads. This was an increase of 738 compared with the number of air-conditioned passenger cars on January 1, 1939.

Of the total number of such cars, Class I roads on January 1, this year had 6,596, an increase of 574 compared with the same date last year. The Pullman Company on January 1, this year had 5,119 air-conditioned passenger cars in operation which was an increase of 164 compared with January 1, 1939.

Average Speed of Freight Trains in 1939

RAILROADS of the United States in 1939 attained a new high record in the average speed of freight trains, J. J. Pelley, president of the Association of American Railroads announced on February 28. The average speed, according to reports for the year which have just become available, was 62 per cent higher than in 1920.

The average distance traveled per freight train per day in 1939, was 401 miles compared with 398 miles in 1938, and 386 miles in 1937. In 1920, the average was only 247 miles. This represents the average time required for the movement of all freight trains between terminals, including all delays en route.

Federal Locomotive Inspector At Memphis Dies

CLARENCE L. WILSON, who retired as federal inspector of locomotives at Memphis, Tenn., on November 30, 1939, died on February 29. Mr. Wilson, who was born on August 29, 1874, had been federal inspector at Memphis since October 10, 1911. He had previously been in the employ of the Illinois Central, for six years as a boilermaker for seven months as a boiler inspector, and for over six years as foreman boilermaker.

B. & O. Diesel Completes 365th Daily Run Without a Miss

WHEN the Baltimore & Ohio's locomotive No. 56 pulled into Washington, D. C., with the Capitol Limited on February 25, it completed its 365th daily run between Chicago and Washington for a full year without a miss, for a total of more than 280,000 miles. Its performance is claimed to be a new all-time world record of 100 per cent availability for a 12-months' period. The 772-mile run of the Capitol Limited calls for a regularly scheduled average speed of more than 56 m. p. h.—including ten regular stops—over a route which includes some of the heaviest mountain grades in the East.

The train regularly consists of from 11 to 15 Pullman cars of standard weight. In completing the 365 consecutive trips locomotive No. 56 made its arrival in the morning, and departure the same afternoon

(*Continued on next left-hand page*)

Orders and Inquiries for New Equipment Placed Since the Closing of the March Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Loco.	Builder
Atchison, Topeka & Santa Fe	4	2,000-hp. Diesel-elec.	Electro-Motive Corp.
Chicago, Milwaukee, St. Paul & Pacific	10	4-8-4	Baldwin Loco. Wks.
	12	600-hp. Diesel-elec.	Electro-Motive Corp.
	1	1,000-hp. Diesel-elec.	American Loco. Co.
	2	600-hp. Diesel-elec.	American Loco. Co.
	1	600-hp. Diesel-elec.	Baldwin Loco. Wks.
	1	300-hp. Diesel-elec.	Baldwin Loco. Wks.
	1	360-hp. Diesel-elec.	General Electric Co.
Delaware, Lackawanna & Western	11	600-hp. Diesel-elec.	Electro-Motive Corp.
	3	600-hp. Diesel-elec.	American Loco. Co.
Lehigh Valley	3	600-hp. Diesel-elec.	Electro-Motive Corp.
	1	600-hp. Diesel-elec.	American Loco. Co.
New York Central	35	Mohawk	American Loco. Co.
	15	Mohawk	Lima Loco. Wks.

LOCOMOTIVE INQUIRIES

Iranian State Railways	12-24	2-8-2 or 2-10-2	.....
Tennessee Central	1-5	Locomotive tenders	.....
United Fruit Co.	4*	2-8-2	.....

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
C. B. & Q.	100	70-ton hoppers	Company shops
	25	Gondolas	Company shops
	25	Auto-parts box	Company shops
Illinois Central	62	70-ton hoppers	Gen. American Tran. Co.
New York Central	500	Box	Pullman-Std. Car Mfg. Co.
	500	Box	Pressed Steel Car Co.
	1,500	55-ton hoppers	Despatch Shops, Inc.
Tennessee Copper Co.	8	50-ton air-dump	Pressed Steel Car Co.

FREIGHT-CAR INQUIRIES

Chesapeake & Ohio	100	50-ton flat	.....
Nashville, Chattanooga & St. Louis	200	50-ton gondola	.....
	50	50-ton hoppers	.....
Norfolk Southern	40	Pulpwood	.....
	12	Caboose	.....
North West Refrigerator Line Co.	100	40-ton refrigerator	.....
	100	50-ton refrigerator	.....

* For service in South America.



NEW!

.....and it's doing a grand job

The new 2-8-8-4 type steam locomotive illustrated, is one of twelve recently delivered by Lima Locomotive Works to the Southern Pacific for use on high-speed passenger and freight runs in mountainous country. Locomotives such as these are Lima's answer to today's increasing traffic demands.

LIMA LOCOMOTIVE WORKS, INCORPORATED, LIMA, OHIO

LIMA LOCOMOTIVE WORKS INCORPORATED

at each terminal, so that the longest period during the entire year in which it was idle for servicing was 6½ hours. No. 56 is a 3,600-hp. unit built by Electro-Motive Corporation in 1938.

Railroads in North Jersey Reduce Smoke 95 P. C. Since '31

RAILROADS operating in Hudson County, N. J., (the largest terminal area across the Hudson river from New York) have made a reduction in smoke of more than 95 per cent since 1931, according to W. G. Christy, smoke abatement engineer of the county, in his annual report. Comparison is based on 10,396 Ringelmann chart smoke readings which show an average density of locomotive smoke in 1939 of 0.543 per cent, compared with an average density of 16.03 per cent during 1931. The New York, Ontario & Western made the best record of any road with an average of 0.145 per cent density. The West Shore (New York Central) was second on the list with an average of 0.226 per cent.

W. E. Dunham Accepts Editorial Assignment

IN the 1940 edition of the Car Builders' Cyclopedia, compiled and edited for the Association of American Railroads, Mechanical Division, by the Simmons-Boardman Publishing Corporation, which is expected to be ready for distribution early this fall, more space will be devoted to car repair, shop layouts, machine equipment and methods of operation necessary to meet modern requirements. Section 19 of the Cyclopedia on "Car Shops and Car Maintenance," will be rewritten and enlarged, and arrangements have been made to have this done by W. E. Dunham, recently retired superintendent of the car department of the Chicago & North Western and the Chicago, St. Paul, Minneapolis & Omaha. Mr. Dunham, whose career was outlined in the March issue of the *Railway Mechanical Engineer*, will bring to his assignment an intimate and extensive knowledge of all phases of railway car maintenance.

1939 Fuel-Efficiency Record

A NEW high record in fuel efficiency in freight service was established by the railroads of the United States in 1939, J. J. Pelley, president of the Association of American Railroads announced on February 29. For each pound of fuel consumed in freight service, the railroads in 1939 hauled 8.89 tons of freight and equipment a distance of one mile, the highest average on record. In 1938, the average was 8.7 tons, and in 1937, it was 8.6 tons. In 1920, the average was only 5.8 tons.

On the basis of a haul per mile of 1,000 tons of freight and equipment, the railroads in 1939 used an average of 112 lb. of fuel, which amounted to an increase of 35 per cent in fuel efficiency compared with 20 years ago, at which time 172 lb. of fuel were required to perform the same service. In 1938, the average was 115 lb. and in 1937 it was 117 lb. of fuel.

In passenger service the railroads in 1939 used 14.8 lb. of fuel in order to haul a passenger train car one mile, which represented an increase of 21 per cent in fuel efficiency in passenger service, compared with 1920 when the average was 18.8 lb. The average in 1939 was a decrease of one tenth of one pound compared with 1938, and a decrease of three tenths of one pound compared with 1937.

Summer Graduate Institute

A THREE-TERM Summer Graduate Institute for engineers, professional men, industrialists, and educators in engineering and science will be conducted by the Armour Institute of Technology, Chicago, beginning with the summer of 1940. According to Dr. L. E. Grinter, vice-president and dean of the graduate division, who is in charge of the summer institute, each summer scientists of distinction will be invited to lecture on modern developments in engineering and science.

The institute is divided into seven separate and distinct divisions—advanced mechanics, chemical engineering and chemistry, civil and sanitary engineering, electrical engineering and physics, mechanical engineering, industrial engineering, and applied mathematics. The typical graduate course will meet for the equivalent of two hours' lecture daily, including Saturdays, for four weeks. Students will be permitted to carry only one course for credit during each period of four weeks, each such course being credited toward advanced degrees. The terms will be from June 17 to July 13; from July 15 to August 10, and from August 12 to September 7.

In future years the Summer Graduate Institute will be conducted under the direction of the Armour College of Engineering of the Illinois Institute of Technology. This will result from the merger of Armour and Lewis Institutes, which is expected to become effective as of September, 1940, and the subsequent changing of the name of the new combined colleges to the Illinois Institute of Technology.

Equipment Depreciation Orders

EQUIPMENT depreciation rates for 22 railroads including the Chicago, Milwaukee, St. Paul & Pacific, the Norfolk & Western, the Western Maryland, and the Spokane, Portland & Seattle, have been prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15100, Depreciation Charges of Steam Railroad Companies. The composite percentages for all equipment, which are not prescribed rates, range from 2.96 for the Louisville & Wadley to 10.5 for the Colorado, the 15 per cent composite figure for the Angelina & Neches reflecting merely the rate on passenger-train cars, the only equipment covered in the modification of the previous sub-order applying to that road.

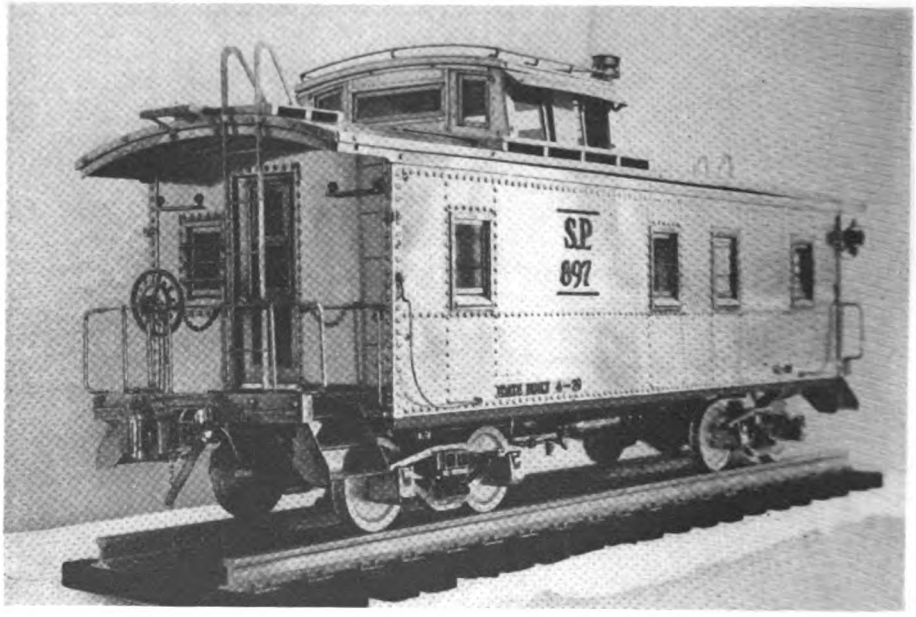
The Milwaukee's composite percentage of 4.15 is derived from prescribed rates as follows: Steam locomotives, owned, 4.35 per cent, leased, 3.17 per cent; other locomotives, owned, 3.69 per cent; freight-train cars, owned, 4.12 per cent, leased, 3.54 per cent; passenger-train cars, owned, 3.76 per cent, leased, 4.37 per cent; floating equipment, owned 4.74 per cent; work equipment, owned, 6.54 per cent, leased, 6.87 per cent; miscellaneous equipment, owned, 15.53 per cent, leased, 15.93 per cent.

The composite percentage for the Spokane, Portland & Seattle is 3.32 per cent, derived from prescribed rates as follows: Steam locomotives, new, 2.73 per cent, rebuilt and second-hand, 4.04 per cent; freight-train cars, new 3.17 per cent, rebuilt and second-hand, 7.14 per cent; passenger-train cars, 2.64; work equipment, new, 2.69, rebuilt and second-hand, 4.14; miscellaneous equipment, 13.29.

Prescribed rates for the N. & W. are as follows: Steam locomotives, 3.63 per cent; other locomotives, 3.08 per cent; freight-train cars, 3.55 per cent; passenger-train cars, 3.31 per cent; floating equipment, 3

(Continued on next left-hand page)

* * *



A caboose-car model built by J. M. Fesco of Los Angeles, Calif.
The model, built of aluminum, brass, stainless steel and Dural, weighs 30 lb. — It has working automatic couplers, draft gear, hand brakes, etc., and is complete in detail even to interior appointments—The builder is a locomotive fireman on the Southern Pacific.



It weighs only 10 lbs.

. . . yet makes possible a better lubricating job

Weight has been drastically reduced in the new No. 8 Combined Lubricator & Spreader . . . and an even better lubricating job is being done. This has been made possible by the use of fabricated steel, and results in a stronger, more snugly fitting unit that weighs less than half of the old cast steel spreader, cellar and end plate. The new cellar, which weighs only 10 lbs. (43 lbs. less), is reversible and more easily handled. By reversing, tapered grease cakes may be fully consumed, thus increasing mileage and decreasing the cost of lubrication. Specify the Franklin No. 8 Lubricator & Spreader for new power and for replacements.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

per cent; work equipment, 3.07 per cent; miscellaneous equipment, 16.5 per cent. For the Western Maryland the prescribed rates are as follows: Steam locomotives, 3.28 per cent; freight-train cars, 3.58 per cent; passenger-train cars, 2.49 per cent; floating equipment, 2.47 per cent; work equipment, 3.71 per cent; miscellaneous equipment, 9.91.

Canadian National 4-8-4 Type Locomotives

THE first of an order of fifteen 4-8-4 locomotives was delivered to the Canadian National on March 21 by the Montreal Locomotive Works, Ltd. The plans and specifications for these locomotives were prepared under the supervision of John Roberts, chief of motive power and car equipment of the C. N. R. While similar in basic design to locomotives built by the same company for this railroad in 1929, the new locomotives have been modified to permit the installation of equipment not used on the older locomotives. The changes include the installation of auxiliary engines on the trailer trucks, roller bearings on the engine, trailer, and tender trucks, and the application of smoke deflectors.

The locomotives have 73-in. drivers, 25½-in. by 30-in. cylinders, and the boilers carry a pressure of 250 lb. The total weight of the engine and tender in working order is 686,700 lb. The tender loaded with 11,600 gallons of water and 20 tons of coal weighs 284,000 lb. The total weight of the engine—402,700 lb.—is 19,700 lb. more than the total weight of the engines built in 1929. They have a tractive force of 57,000 lb. with an additional 10,000 lb. supplied by the auxiliary engine.

Although the locomotives are primarily intended for use in fast freight service, their characteristics make them adaptable also for use in heavy passenger service.

Equipment Purchasing and Modernization Programs

Chicago, Milwaukee, St. Paul & Pacific.—The 1940 improvement budget of the Milwaukee, which provides for the expenditure of $8,00,000 has been approved by the federal district court.

A total of 2,000 steel box cars and 25 steel, wood-lined cabooses will be built in company shops, and 25 steel coaches will be remodeled and air conditioned.

Orders for the ten steam and 18 Diesel-electric locomotives have been placed as shown in the table of orders for equipment placed since the closing of the March issue.

The $8,000,000 includes only 20 per cent of the cost of the new steam locomotives and box cars, the remainder being covered by equipment trust certificates to be taken by the R. F. C. The Diesel-electric locomotives will be acquired on a lease-purchase plan.

Chicago, Rock Island & Pacific.—The federal district court has authorized the expenditure of $1,528,000 for five more Rockets. The equipment for these trains will include two 1,000 hp. and three 2,000 hp. Diesel-electric locomotives, three cafe lounge, three chair, two coaches and two mail-baggage cars. Of these, six cars and two locomotives will be used in one train each way daily between Memphis, Tenn., and Amarillo, Tex., to replace the present steam train between Little Rock, Ark., and Amarillo, and the present steam and motor car service between Little Rock and Memphis. Two cars and two locomotives are for one train in each direction daily between Kansas City, Mo., and Colorado Springs, Colo., to replace steam-train service. Two cars and one locomotive are for one train daily between St. Louis, Mo., and Minneapolis, Minn., and will replace steam trains operated between Burlington, Iowa, and Manly. It will be operated in conjunction with the Chicago, Burlington & Quincy.

It is asserted that these new trains will produce operating savings of $192,279 and additional revenue of $350,000. To finance the new equipment the court authorized the Rock Island to sell 1,243 refrigerator cars to the General American Transportation Corporation for $1,345,235 and apply part of this money to the purchase of the new equipment. These refrigerator cars were leased to General American in 1932.

Louisville & Nashville.—The L. & N. has been engaged at its South-Louisville, Ky. shops, on a modernization program converting 1,000 wooden-sided, single-sheathed box and automobile cars to all-steel box cars. The work of dismantling the old cars and building the new cars from the underframe up was begun in December, 1939.

P. S. & N. Asks Relief from Automatic Stoker Order

THE Pittsburg, Shawmut & Northern has asked the Interstate Commerce Commission to be relieved from the automatic stoker order so that it may operate its old locomotives without automatic stokers up to April 15, 1944, the date when all heavy locomotives in high-speed service must be so equipped. The company contends, in its petition, that the engines that it now operates are in slow freight service and are not of sufficient value to justify the cost of installation of automatic stokers. The commission's order had decreed that one-fifth of each road's engines falling in the specified class, must be equipped each year so that all would be so equipped by April 15, 1944.

Supply Trade Notes

HARRY N. HAYES, Chicago district sales manager of the Coffing Hoist Company, Danville, Ill., has been promoted to the position of general sales manager.

◆

JOHN F. MCDONNELL has been appointed western manager of the Railroad division of the Home Rubber Company, New York. Mr. McDonnell's office is at 168 North Clinton street, Chicago.

◆

EDGAR C. THOMAS, sales engineer of the Thomas Machine Manufacturing Company, Pittsburgh, Pa., has established an eastern district sales office for the company at 1258-W Commercial Trust building, Philadelphia, Pa.

◆

DAVID T. MARVEL, formerly manager tube sales, Timken Steel and Tube Division of Timken Roller Bearing Co., Canton, Ohio, has entered the service of the National Tube Company as assistant manager of sales, Ellwood Sales Division, Ellwood City, Pa.

TEMPLETON, KENLY & COMPANY.—*J. B. Templeton,* vice-president, Chicago, has been elected president to succeed *W. B. Templeton,* who is now chairman of the board. J. B. Templeton has been associated with the company since 1928. After working in the shops and office, he entered the sales department and later became manager of the New York office. In 1935, when W. B. Templeton, who founded the firm in 1899, traveled to develop the company's business in foreign countries and remote parts of the world, J. B. Templeton assumed the duties of vice-president and sales manager.



J. B. Templeton

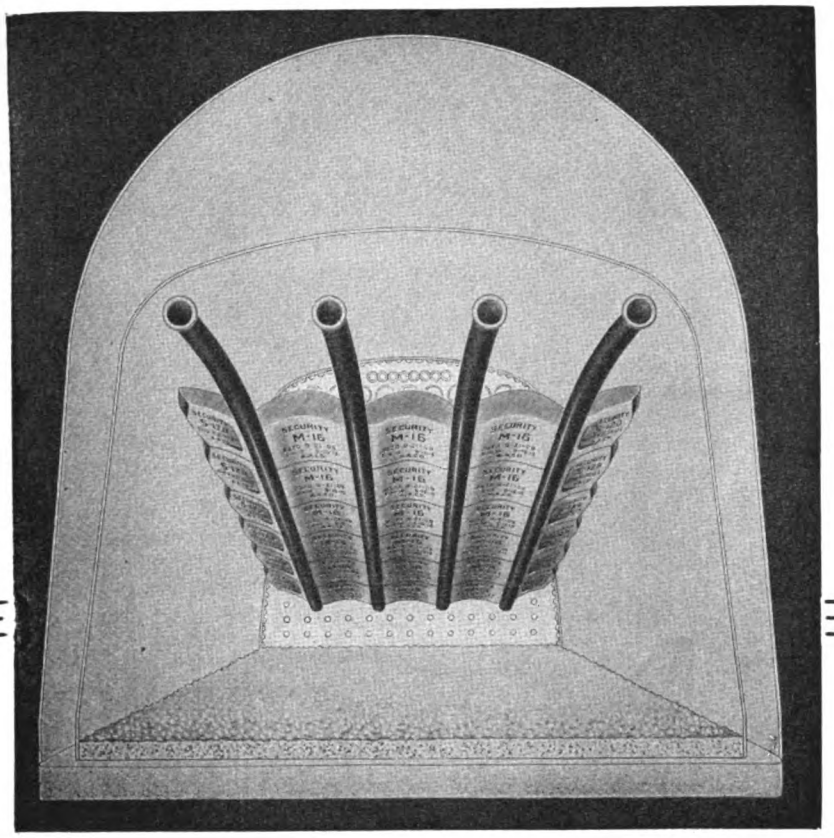
◆

LANDIS MACHINE COMPANY.—*C. N. Kirkpatrick* has been elected vice-president and general manager, and *J. H. Elliott,* secretary, of the Landis Machine Company, Waynesboro, Pa. Mr. Kirkpatrick was formerly vice-president in charge of sales and secretary of the company. Mr. Elliott continues also as purchasing agent.

◆

TIMKEN ROLLER BEARING COMPANY.—*William H. Richardson,* general manager

(*Continued on next left-hand page*)



ANYTHING

less than a complete arch

IS FALSE ECONOMY

To let the desire for reduced inventory result in a locomotive leaving any roundhouse without a full set of Arch Brick is poor economy. » » » Even a single missing Arch Brick will soon waste many times its cost in fuel and in locomotive efficiency. » » » To spend the fuel dollar efficiently, every locomotive Arch must be maintained 100%. » » » Be sure your stocks on hand are ample to provide fully for all locomotive requirements, so that locomotive efficiency may be maintained.

There's More to SECURITY ARCHES Than Just Brick

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.

Locomotive Combustion Specialists

of the service-sales division of the Timken Roller Bearing Company, Canton, Ohio, has been appointed assistant general sales manager. Mr. Richardson has been succeeded by *E. H. Austin,* assistant general manager of the sales-service division. *R. P. Proffit,* representative at Chicago, has been promoted to Chicago division manager. *Jay Irwin* has been appointed Chicago district manager of the steel and tube division, Canton.

◆

JOHN A. DILLON who has resigned as vice-president in charge of eastern sales at New York of the Pittsburgh Screw & Bolt Corporation, Pittsburgh, Pa., has formed the Standard International Sales Corporation, with an office in the New York Central building, New York. Mr. Dillon is president of the company and Norman Allderdice vice-president and secretary. The company will engage in export and domestic sales of steel and allied products, specializing in sales to railroads, car and locomotive builders, ship-builders and oil companies.

◆

GENERAL ELECTRIC COMPANY.—Three appointments have been made in the Transportation department at Erie, Pa.: *E. W. Brandenstein* has been appointed head of the Railroad Electrification section, *E. E. Kearns,* head of the Urban Equipment section, and *R. D. Krape,* head of the Diesel-electric Locomotive section.

R. D. Krape began work with the General Electric in 1911, following his graduation from Pennsylvania State College. In 1913, he joined the railway equipment engineering department in Schenectady, and



R. D. Krape

since 1926, has been a commercial engineer in the general office of the Transportation department at Erie.

◆

THE AMERICAN BRAKE SHOE & FOUNDRY COMPANY has purchased the Great Lakes Forge Company of Chicago which will be operated as the American Forge Division of the American Brake Shoe & Foundry Company.

◆

LUKENS STEEL COMPANY.—*George L. Gordon,* in charge of the New York office of the Lukens Steel Company, has been transferred to the company's main office at Coatesville, Pa. *J. J. Reynolds,* sales representative in the New York office for the past 13 years, has been appointed manager of sales at New York.

◆

ROBERT G. SONQUIST, who has been associated with the American Steel Foundries for the past 21 years, has resigned and accepted a position in the New York office of the Standard Railway Equipment Company.

◆

THE GARLOCK PACKING COMPANY.—*F. E. Erlandson,* district manager at St. Louis, Mo., of The Garlock Packing Company, Palmyra, N. Y., has been appointed district manager of the company's Cleveland, Ohio, branch succeeding *R. W. Perkins,* resigned. *H. J. Kuhn,* sales representative of the St. Louis, Mo., branch, has been appointed manager of that branch to succeed Mr. Erlandson.

◆

AMERICAN STEEL FOUNDRIES.—A. W. MacLaren, assistant vice-president, with headquarters at New York, has been elected vice-president with the same headquarters, to succeed W. J. Lynch, retired. E. M. Van Winkle succeeds Mr. MacLaren as sales agent at New York.

A. W. MacLaren entered railway service in 1898 in the accounting department of



A. W. MacLaren

the Cleveland, Cincinnati, Chicago & St. Louis, at Cincinnati, and in 1899, was promoted to chief clerk in the passenger department, with the same headquarters. In 1902 he became secretary to the president, and in 1905, when the Big Four became a part of the New York Central System, he was promoted to assistant to the vice-president in charge of traffic of the New York Central, with headquarters at Chicago. In 1907 he was transferred to New York, and in 1910 resigned to become general traffic manager of Morris & Company, Chicago. In 1923, he resigned to become vice-president in charge of sales of the Chicago Bearing Metal Company, Chicago, and in the following year entered the employ of the American Steel Foundries as sales agent at New York. In 1930, he was appointed assistant vice-president.

E. M. Van Winkle graduated from Purdue University in 1921 as a chemical engineer and immediately entered the employ of the American Steel Foundries as a special apprentice. After serving in various capacities, he was employed in the industrial sales department for ten years and in June, 1939, was appointed sales agent at New York.



E. M. Van Winkle

W. J. Lynch entered the employ of the American Steel Foundries as vice-president in 1911. For a number of years previous he was employed by the New York Central.

◆

W. C. DABNEY, president of the Jones-Dabney Company, Louisville, Ky., has been elected a vice-president of Devoe & Raynolds Company, Inc., with supervision of Devoe's Railroad and Marine Paint divisions. Mr. Dabney will have his headquarters, as formerly, at Louisville.

◆

LUKENWELD, INC.—*Edward J. Charlton* has been appointed general manager of Lukenweld, Inc., Coatesville, Pa.; *Robert L. Bunting,* superintendent; *George L. Snyder,* chief engineer; *D. Bruce Johnston,* manager of development and research; *Robert B. Nivison,* chief of inspection; *Robert C. Sahlin,* assistant manager of sales; *S. Nelson Buell,* assistant chief engineer; *Fred W. Forbes,* assistant superintendent; *W. J. McAlpine,* general foreman, and *George Wheatley,* methods engineer.

◆

GEORGE H. HOUSTON, formerly president of the Baldwin Locomotive Works, has joined with Hendrik R. Jolles to form the firm of Houston & Jolles, industrial and financial consultants, with office at 52 Wall street, New York. Edward W. Higgins, also formerly with the Baldwin Locomotive Works, is associated with Houston & Jolles.

Obituary

DAVID C. JONES, vice-president and general manager of The Lunkenheimer Company, Cincinnati, Ohio, died on March 11, after a brief illness. He was born at Cincinnati on November 14, 1876, and entered the employ of the Lunkenheimer Company in January, 1894. Mr. Jones also had served as president of the American Supply & Machinery Manufacturers' Association.

Personal Mention

General

A. E. COLEMAN has been appointed superintendent of the St. Clair tunnel, Canadian National, with jurisdiction over all mechanical and electrical operation, succeeding M. J. Nottingham, who has been assigned to other duties.

B. H. SMITH, whose appointment as superintendent of motive power of the Second district of the Chicago, Rock Island & Pacific, with headquarters at Kansas City, Mo., was announced in the March issue, entered railway service on September 1, 1894, as a machinist apprentice on the Northern Pacific at Brainerd, Minn. He later served as a machinist on various roads from January, 1900, until May, 1903, when he became enginehouse foreman on the Atchison, Topeka & Santa Fe at Chicago. In May, 1904, he was appointed division foreman at Marceline, Mo., later being transferred to Emporia, Kan. In January, 1907, he became a representative of a railroad supply company and in October, 1908, went to Caldwell, Kan., as general foreman of the Chicago, Rock Island & Pacific. Mr. Smith entered the employ of the Kansas City, Mexico & Orient (now part of the Santa Fe system), in March, 1911, as general foreman at Emporia, Kan., and in October, 1914, returned to the Rock Island as general foreman at Fairbury, Neb. In October, 1918, he was appointed master mechanic, serving successively at various points, including Fairbury, Estherville, Iowa, Horton, Kan., Little Rock, Ark., and Des Moines, Iowa.

JOHN S. MORRIS, who has been appointed electrical engineer of the New York, Chicago & St. Louis, with headquarters at Cleveland, Ohio, was born on February 11, 1892, at Denison, Tex. He was a graduate in mechanical and electrical engineering from Cornell University in 1917. In June of that year he entered railroad service on the New York, Chicago & St. Louis as a special apprentice. Two years later he became assistant engineer. From 1923 to 1933 Mr. Morris served successively as engineer of shops and machinery, general foreman and mechanical inspector. For the next three years he worked as master mechanic on the Chicago Great Western, rejoining the New York, Chicago & St. Louis in 1936 as mechanical assistant.

Master Mechanics and Road Foremen

E. J. CYR, master mechanic of the Chicago, Burlington & Quincy at McCook, Neb., has been transferred to Chicago.

C. F. DENO, division master mechanic on the Canadian Pacific at Moose Jaw, Sask., has been transferred to Regina, Sask.

AUGUST THOMAS, locomotive foreman on the Canadian Pacific at Moose Jaw, Sask., has been appointed division master mechanic, with the same headquarters, succeeding C. F. Deno.

C. S. HOGAN has been appointed master mechanic of the McCloud River Railroad, with headquarters at McCloud, Calif., succeeding to a portion of the duties of John Kennedy.

WILLIAM SCHWARTZ, day enginehouse foreman of the Chicago, Burlington & Quincy, at Casper, Wyo., has been appointed master mechanic at that point.

C. E. BLOOM, maser mechanic of the Chicago, Burlington & Quincy at Casper, Wyo., has been transferred to McCook, Neb.

C. E. FARLEY, master mechanic of the Chicago, Rock Island & Pacific at Silvis, Ill., has been transferred to Des Moines, succeeding Mr. Smith.

D. N. MEYERS, special duty engineman on the Ft. Wayne division of the Pennsylvania, has been appointed assistant road foreman of engines of the Logansport division, with headquarters at Logansport, Ind.

H. C. MCCULLOUGH, master mechanic of the Chicago, Rock Island & Pacific at Cedar Rapids, Iowa, has been transferred to Silvis, Ill.

CHARLES L. CHRISTY, day enginehouse foreman on the Missouri Pacific at Falls City, Neb., has been promoted to assistant master mechanic at Wichita, Kan., succeeding T. C. Carter.

S. E. MUELLER, superintendent of the second district of the Chicago, Rock Island & Pacific at Kansas City, Mo., has been appointed master mechanic at Cedar Rapids, Iowa.

FRANK J. TOPPING who has been appointed master mechanic of the Chesapeake & Ohio at Hinton, W. Va., as announced in the February issue, was born on May 10, 1890, at Roanoke, Va. He attended the



Frank J. Topping

public schools of Virginia and received his technical training through the International Correspondence Schools. He entered the employ of the C. & O. in June, 1907, and until 1911 was a machinist apprentice, working two months of his apprenticeship as a storekeeper and three months as a locomotive fireman. He was a machinist on the Norfolk & Western at Williamson, W. Va., and at Roanoke, Va.; on the Virginian at Princeton, W. Va., and Elmore, and on the C. & O. at Hinton, W. Va., Thurmond and Huntingdon, until June 1916. He then served as enginehouse foreman of the C. & O. at Ronceverte, W. Va., and Clifton Forge, Va., respectively, until January 1, 1919, when he became air brake machinist at the latter point. Upon his promotion to the position of general foreman on September 1, 1919, Mr. Topping served at Ronceverte until June 20, 1923; at Clifton Forge until March 15, 1933, and at Hinton until October 15, 1937. On that date he was appointed assistant master mechanic, with headquarters at Hinton; on October 1, 1938, became assistant master mechanic of the Cincinnati division, and on January 1, 1940, returned to Hinton as master mechanic.

J. W. MCCARTHY, road foreman of engines of the Erie at Hornell, N. Y., has retired. Mr. McCarthy had been in the service of the Erie for 49 years.

PETER HESSBERGER, road foreman of engines of the Erie at Port Jervis, N. Y., has retired. Mr. Hessberger had been in the service of the Erie for 49 years.

H. G. FULLER, assistant road foreman of engines of the Logansport division of the Pennsylvania, has been appointed assistant road foreman of engines of the Ft. Wayne division, with headquarters at Ft. Wayne, Ind.

Car Department

D. J. HAYES, car foreman at Chapleau, Ont., of the Canadian Pacific, has been transferred to Outremont, Que., succeeding T. J. Payne, retired.

EDGAR EATON, assistant foreman of the Canadian Pacific at Quebec, Que., has been appointed to the position of car foreman at Chapleau, Ont., succeeding D. J. Hayes.

Shop and Enginehouse

J. M. WEBSTER, superintendent of the Bellmead back shops of the Missouri-Kansas-Texas at Waco, Tex., retired on February 1.

T. C. CARTER, assistant master mechanic on the Missouri Pacific at Wichita, Kan., has been appointed day enginehouse foreman at Falls City, Neb.

H. C. GUGLER, master mechanic of the Chicago, Burlington & Quincy at Chicago, has been appointed superintendent of shops at Aurora, Ill., succeeding J. W. Cyr, who has retired.

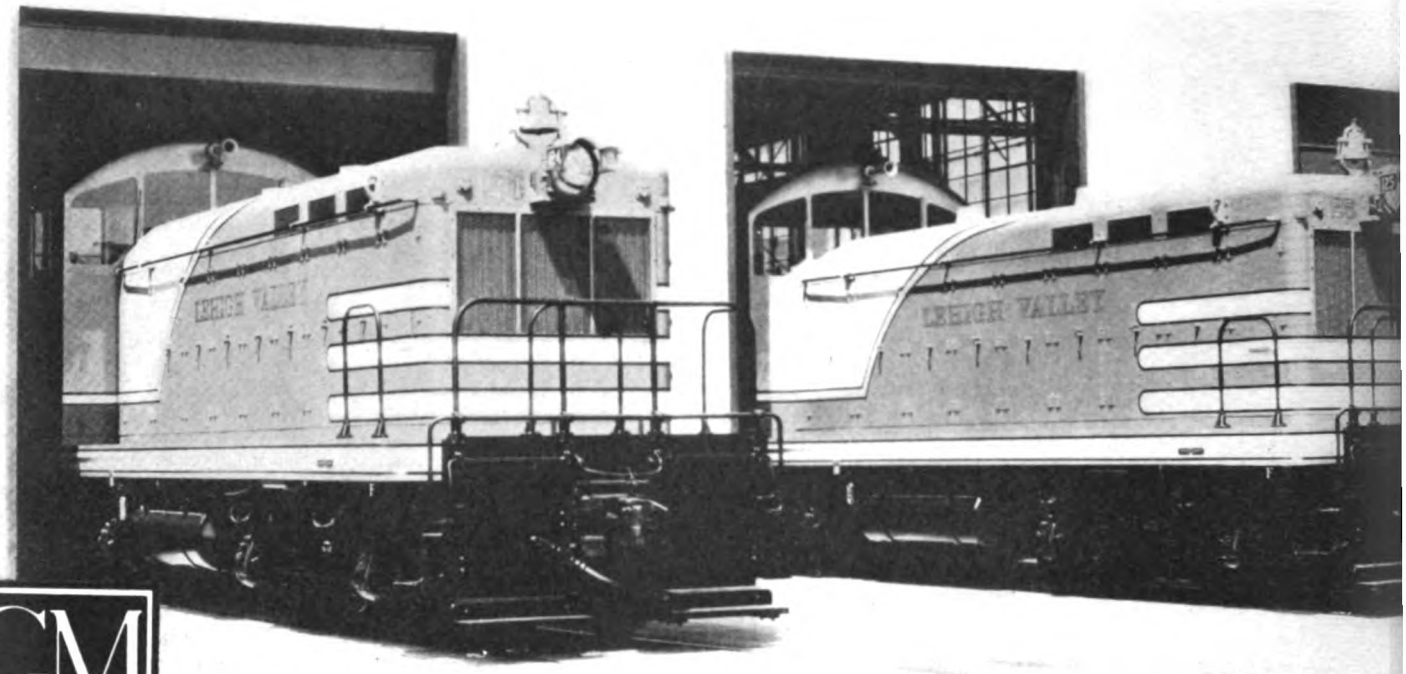
T. H. EVANS, general foreman of the Missouri-Kansas-Texas at Waco, Tex., has been promoted to the position of superintendent of the Bellmead back shops at Waco.

A. C. GUNNING, machinist on the Canadian National at Blue River, B. C., has been promoted to the position of locomotive foreman at Blue River.

WALTER MEDLOCK, day enginehouse foreman of the Denver & Rio Grande Western

(*Continued on second left-hand page*)

PROFIT-PRODUC



GM
GENERAL MOTORS
DIESEL
POWER

EMC DIESELS Do More than Save their Cost in Economies Produced — they provide safer, faster, cleaner, quieter operation . . . . .



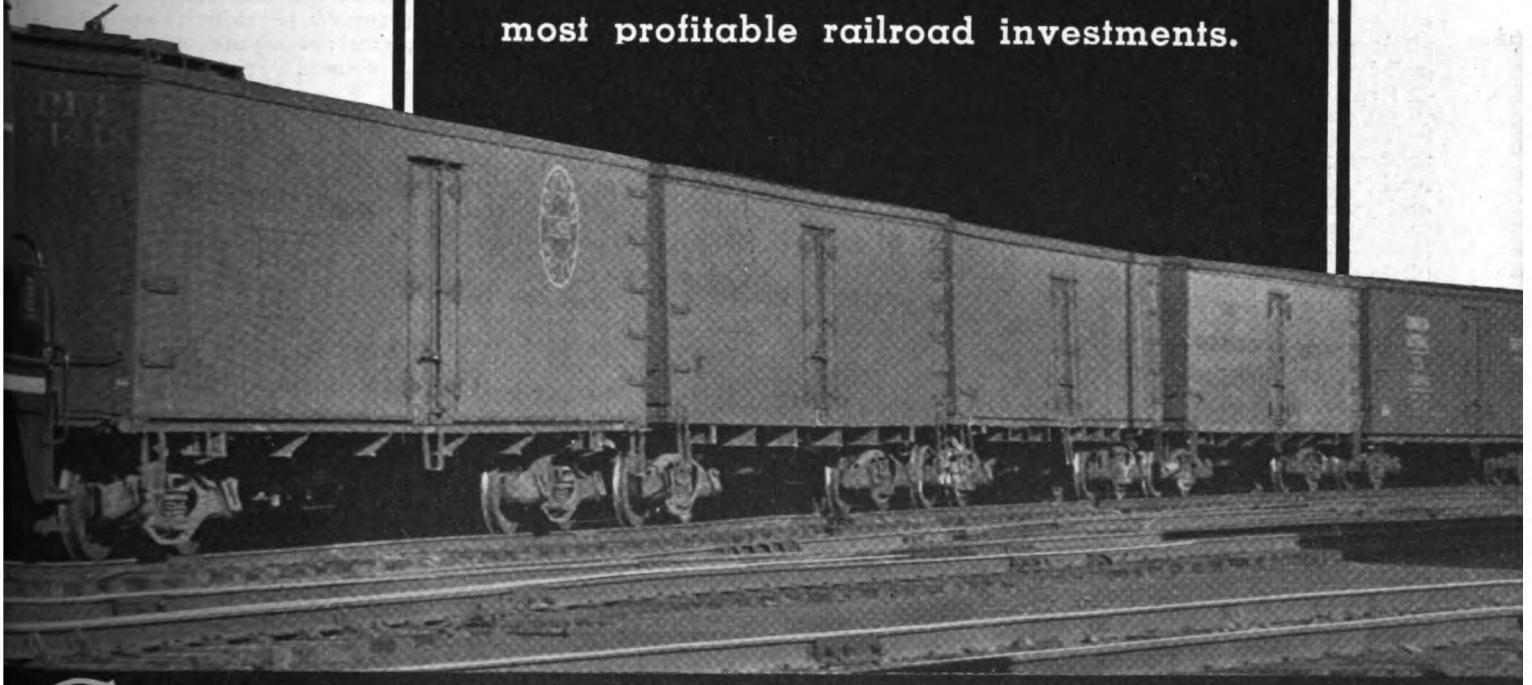
ELECTRO-MOTIVE
SUBSIDIARY OF GENERAL MOTORS

NG EQUIPMENT

— And Higher Operating Standards

THE performance records of over 300 EMC "clear-view" type Diesel switchers with approximately three million hours of operation on more than 50 railroads show the high availability average of 94 per cent, with reduction in locomotive switching costs from 50 per cent to 75 per cent and frequently saving $1,000.00 per month above carrying and amortization charges—normally sufficient to pay for themselves in 5 years. EMC Diesel switchers continue to be one of the most profitable railroad investments.





CORPORATION

LA GRANGE, ILLINOIS, U. S. A.

at Grand Junction, Colo., has been promoted to the position of general foreman, with headquarters at Grand Junction.

J. W. DOUGLAS, locomotive foreman on the Canadian Pacific with headquarters at Kenora, Ont., has been promoted to the position of general foreman at Moose Jaw, Sask.

J. NEILL, night chargehand on the Canadian Pacific at Nelson, B. C., has become locomotive foreman at Nelson.

J. MCRAE, locomotive foreman on the Canadian Pacific at Nelson, B. C., has been transferred to Coquitlam, B. C., succeeding F. C. Johnson.

F. C. JOHNSON, locomotive foreman on the Canadian Pacific at Coquitlam, B. C., has become general foreman at Revelstoke, B. C.

J. S. MCNEIL, locomotive foreman on the Canadian National at Blue River, B. C., has been transferred to the position of locomotive foreman at Kamloops Junction, B. C.

GEORGE P. BOWMAN, assistant foreman in the erecting shop of the Norfolk & Western at Roanoke, Va., has been appointed general foreman at Shaffers Crossing shops, Roanoke.

J. A. MARTIN, assistant foreman on the Canadian Pacific at Quebec, Que., has become assistant foreman, with the same headquarters, succeeding Edgar Eaton.

Purchasing and Stores

U. K. HALL, general storekeeper of the Union Pacific, with headquarters at Omaha, Neb., retired on March 31, because of ill health, after 42 years continuous service on the Union Pacific. Mr. Hall was born at Portland, Ore., on September 12, 1878, and entered railway service in 1897 with the Union Pacific System. He advanced through various positions in the purchasing, accounting, operating, engineering and stores departments. He was appointed general storekeeper of the Oregon-Washington Railroad & Navigation Company (now a part of the Union Pacific) at Portland, Ore., in 1913, which position he held until 1916 when he was sent to Omaha as general storekeeper of the Union Pacific. During the World War Mr. Hall was stationed at Washington, D. C., as assistant to the manager of stores of the United States Railroad Administration. Following the war he was appointed general supervisor of stores of the Union Pacific System, which position he held until April, 1932, when his title was changed to general storekeeper of the system. In January, 1933, he became general purchasing agent, with headquarters at Omaha, and in August, 1937, was re-appointed general storekeeper. Mr. Hall served as chairman of the Purchases and Stores division of the American Railway Association in 1923-24 and is at present a member of the advisory committee of the P. and S. Division.

* * *



Moving the 2,000-Hp. Electro-Motive Diesel-electric locomotive into the General Motors 1940 exhibit at the New York World's Fair

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

MATERIAL-HANDLING EQUIPMENT.—Lewis-Shepard Sales Corp., Watertown, Mass. Catalogue No. 21 of floor and hand trucks, skid platforms, cranes, stackers, etc.

◆

BEARING BRONZE.—Johnson Bronze Company, New Castle, Pa. Catalogue 400. Describes over 800 sizes of plain bearings, with more than 350 listings of bronze bars.

◆

STEEL.—Republic Steel Corporation, Republic building, Cleveland, Ohio. Two-color, 40-page catalogue, Form Adv 353, on Republic Double Strength steel, with seventeen pages showing applications in specific industries.

◆

SPRINGS.—Fort Pitt Spring Company, P. O. Box 1377, Pittsburgh, Pa. 36-page illustrated catalogue, No. 4. Elliptic freight-truck, equalizing, compression, coil, and helical springs, with specifications, calculations, formulas and other useful data.

◆

LATHES.—The R. K. LeBlond Machine Tool Co., Edwards & Madison Road, Hyde Park, Cincinnati, Ohio. Colorful 50-page spiral-bound book, "March of the Masters," shows part lathe has played in development of great men and industry and describes LeBlond line of Regal and Super Regal lathes.

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SPRAY-PAINTING EQUIPMENT.—The DeVilbiss Company, Toledo, Ohio. 32-page illustrated booklet, "ABC of Spray Painting Equipment." Contains common questions and answers pertaining to operation and use, care and adjustment of spray-painting equipment. Price, 25 cents.

◆

METCOLIZING.—Metallizing Engineering Co., Inc., 21-07 Forty-First avenue, Long Island City, N. Y. Bulletin P-11 describes Metcolizing, a process for protection of iron and steel and some other metals against oxidation and scaling at elevated temperatures.

◆

ARC WELDING ELECTRODES. — Wilson, Welder and Metals Co., Inc., 60 East Forty-Second street, New York. Twenty-four-page booklet descriptive of application, procedure for use, and physical properties of Wilson electrodes for numerous and varied welding purposes. Section devoted to Welding Symbols and Instructions for Their Use.

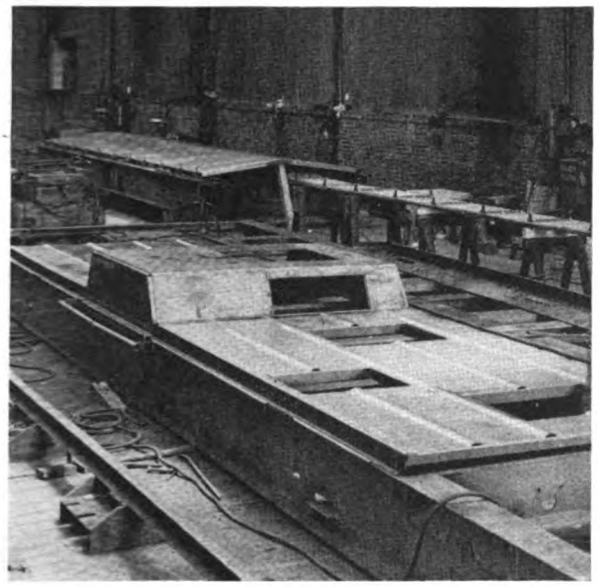
◆

TURRET LATHE TOOLS.—Gisholt Machine Company, 1289 East Washington avenue, Madison, Wis. 40-page catalogue, Form 1059B, describes entire line of Gisholt standard tools for ram type turret lathes, including several new additions such as multiple cutter turners and slide tools.

RAILWAY MECHANICAL ENGINEER

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May, 1940

Volume 114 *No. 5*

Car:

Truck-Spring Snubbers ... 175
Western Maryland All-Welded Flat Cars ... 180
Illinois Central Builds Three Heater Cars ... 186

Locomotive:

Embrittlement in Boilers ... 182
4-8-4 Locomotives for Canadian National ... 187

General:

Barco Joints Improved ... 188

Editorials:

Technological Unemployment ... 190
Brake Instruction for Division Officers ... 190
Flame-Hardened Stoker Screws ... 191
Why Should Diesel Repair Costs Be High? ... 191

Car Foremen and Inspectors:

New Cabooses Built at Milwaukee Shops ... 193
Test Rack for Steam-Heat Connectors ... 196
Sash Cleaning and Glazing Methods ... 197
Air Brake Questions and Answers ... 198
A New Atlas Journal Jack ... 199
Air Transformer for Spray-Painting Process ... 199

Backshop and Enginehouse:

The Reinforcement of Defective Boiler Shells ... 200
Reconditioning Carbon-Steel Springs ... 201
Slotting Rod Bushings on a Shaper ... 202
Gaging the Length of Locomotive Drawbars ... 202
Instructions for Maintaining Diesel-Electric Equipment ... 202
Locomotive Boiler Questions and Answers ... 204
Tubing of Carbon and Alloy Steel ... 205
Remote Control for Arc Welders ... 205

High Spots in Railway Affairs ... 206

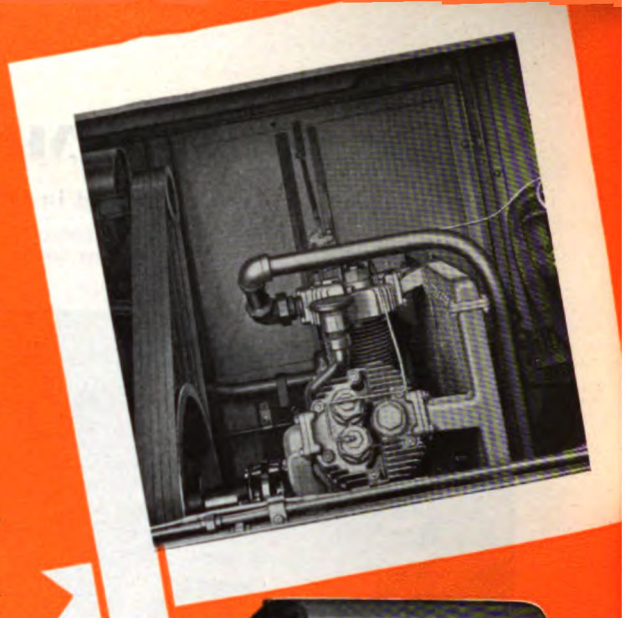
Clubs and Associations ... 207

News ... 208

Index to Advertisers ... (Adv. Sec.) 42

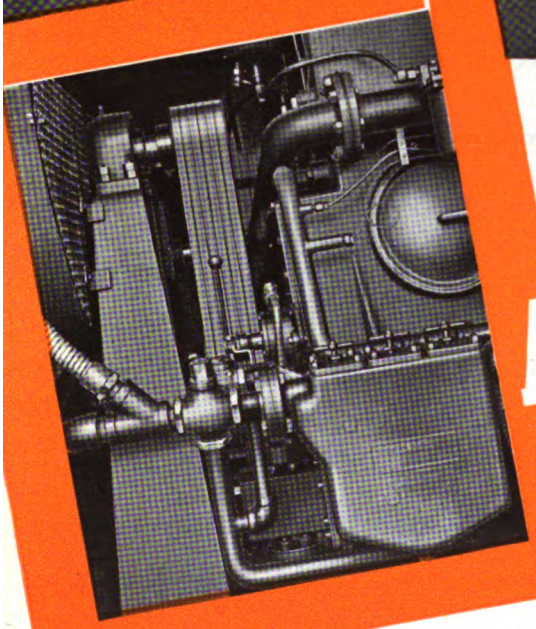
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Truck-Spring Snubbers*

By W. S. Spieth†

The development of the truck-spring snubber—Test data included to show characteristics of coil springs and snubbers acting independently and in combination

THE truck-spring snubber as applied to railroad freight cars is a comparatively new device. Ten years ago there were very few of them in service. Today, many thousands of freight cars are equipped with them and every day they are being applied to more and more new and existing cars. They are used to make cars ride evenly and smoothly, and by doing this they protect the lading and decrease the cost of maintenance of the rolling stock as well as the roadbed.

The freight-car snubber is often referred to as a spring. It fits into and acts as part of a spring group. It possesses some of the functions of coil springs, particularly the ability to cushion or absorb shocks. However, it does not have some of the other characteristics of coil springs, which I will explain later, and the use of coils cannot be wholly eliminated by the substitution of snubbers. This is a fundamental consideration and, because it is sometimes overlooked, I want to emphasize that it is necessary that coil springs be used in combination with snubbers. Also, it is now generally recognized that it is necessary for snubbers to be used in combination with coils in order to effect the most efficient and most economic freight-car operation.

In discussing truck-spring snubbers, therefore, we must consider them in combination with freight-car coil springs and, as the history of coil-spring design and performance is so closely interwoven with snubber development and usage, it is advisable to review this history rapidly as a background for our discussion of truck-spring snubbers.

As was the case with most other freight-car devices "away back when," there were several different designs of coil springs used under cars built by the different railroads and most of them gave a fairly good account of themselves in service. In those days car capacities were not as great as they are today, freight-train speeds were slower, and average yearly freight-car mileages were lower. There was less damage to ladings enroute and the cost of freight-car maintenance had not assumed the proportions it has today. The coil spring was giving satisfactory results in service and it continued to do so for a number of years after the turn of the century. Probably the best evidence in support of this statement is the fact that the spring design that we know today as the A. A. R. 1915 coil was adopted as a standard in 1915 after having been adopted as a recommended practice in 1901.

During this period there was a gradual increase in the size and carrying capacity of freight cars. The car with 100,000 lb. capacity came into general use and a considerable number of cars with 140,000 lb. capacity were built. Some of the coal roads also began to use 90- and 100-ton cars for special services. In the post-war period certain other changes were made in car carrying capacities and operating methods that had a marked effect on spring performance. In 1920 the A. A. R. increased the permissible carrying capacity of the 5½-in. by 10-in. axle from 38,000 lb. to 40,000 lb. and at about the same time changed the interchange car loading rating from a nominal capacity rating plus 10 per cent to an axle-capacity rating. This resulted in a material increase in the maximum loads that cars were permitted to carry.

In this post-war period the railroads, in the interest of better service and more efficient utilization of equipment, began to increase freight-train speeds and average freight-car mileages. These efforts have continued to gather impetus ever since they were inaugurated, and today some freight-car services are contemplated that will require sustained freight-train speeds of 85 and 90 m. p. h.

As car loads, freight-train speeds, and freight-car average mileages were increased, the railroads began to experience a considerable amount of spring breakage which, as time went on, developed into a serious prob-

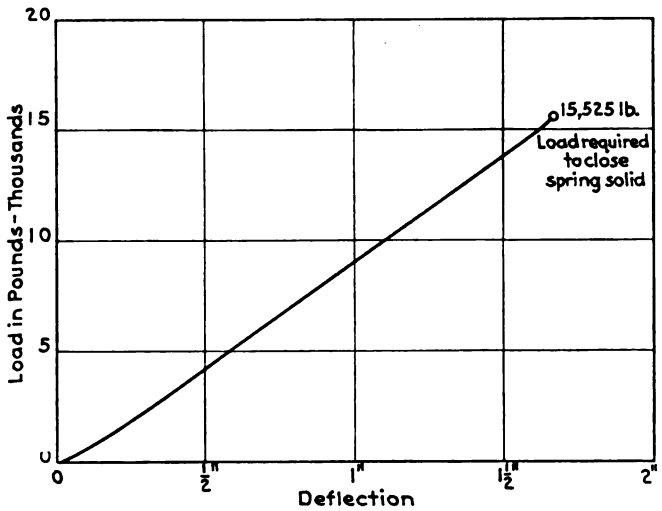


Fig. 1—Calibration curve of a standard A. A. R. 1936 outer coil spring

* Paper presented at the meeting of the Northwest Carmen's Association on March 4, 1940.

† Manager, Simplex snubber department, American Steel Foundries. Mr. Spieth was assisted in the preparation of this paper by J. E. Tarleton, Cardwell-Westinghouse Co.; Cyrus Holland, Holland Company; H. T. Casey, Symington-Gould Corporation, and G. H. Snyder, American Steel Foundries.

lem. Apparently the trouble was not with the design of the coils, as such, because the spring that was now failing had been in use for a number of years and had not developed a design weakness. The logical reason for the failures seemed to be that the spring groups were

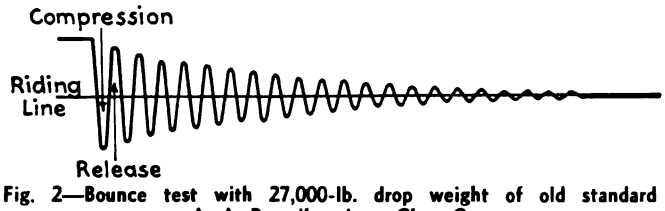


Fig. 2—Bounce test with 27,000-lb. drop weight of old standard A. A. R. coil springs, Class C

being required to carry heavier loads at higher speeds with the result that under these conditions springs were going solid to an appreciable extent. Marks or indentations between the coils of failed springs was evidence that this was a major contributing factor in spring breakage.

The solution of the problem seemed to be increased spring-group capacity and a number of tests were made on cars in service to determine how much increased capacity was required. These tests developed that under the conditions that prevailed at that time the live loads on freight-car spring groups amounted to approximately 2.1 times the corresponding dead or static loads and that spring groups with capacities in excess of this ratio were necessary if springs were to be kept from going solid. This, naturally, led to changes in truck design which provided an increased amount of space in the bolster opening of the side frame to permit the use of an increased number of coil springs and thus an increase in spring group capacity without necessitating a change in coil-spring design. The Dalman and the double-truss designs were developed for this purpose and were generally used.

Shortly after spring breakage reached serious proportions, the question of shippers' claims for materials damaged enroute also became a more serious problem. The packers were among the first to notice this when they began to experience increased losses caused by fresh meat being torn from hooks in cars during shipment. Increases in claims in connection with all fragile materials were experienced and even claims for damage to such items as tile and sewer pipe reached sizeable amounts on some railroads. This increased the scope of the spring investigations when it was developed that the action of the spring groups was having a considerable effect on the size of these damage claims.

In the meantime the Car Construction Committee of

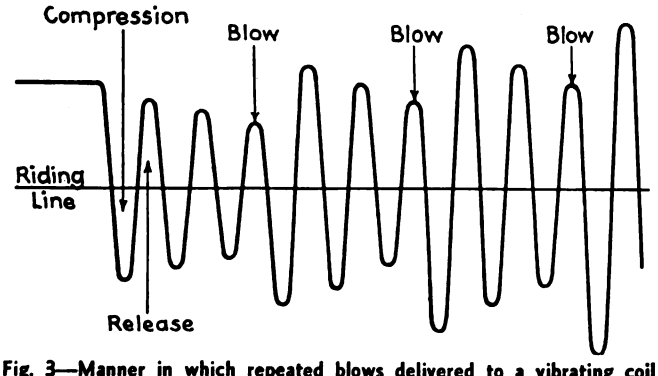


Fig. 3—Manner in which repeated blows delivered to a vibrating coil spring in time with the vibrations increase the amplitude of the oscillations

the American Railroad Association was actively studying the question of freight-car spring design. They made certain changes in the tentative standards in 1921 shortly after acceptable axle-carrying capacities had been increased. In 1932 they recommended a change in coil-spring design which materially increased the carrying capacity of the outer and inner coils. Their recommendation was adopted as a tentative standard in the same year. Subsequently, the Committee revised this design to one having less capacity per coil than the 1932 standard but more capacity than the 1915 standard. This revised design was recommended by the Committee to the Association in 1936 and that year was adopted by the Association as the recommended standard. It is known as the A. A. R. 1936 standard coil spring. One A. A. R. 1936 double coil has approximately 16 per cent more carrying capacity than an A. A. R. 1915 double-coil spring. The increase in capacity is obtained by an increase in the diameter of the bars from which the springs are coiled.

Increased spring capacity, obtained either by the use of more coils or by the use of the 1936 coils, has reduced the tendency of the springs to go solid. However, it has also increased the stiffness of the spring groups, with the result that, at the normal speeds at which freight trains are operated today, lightly loaded

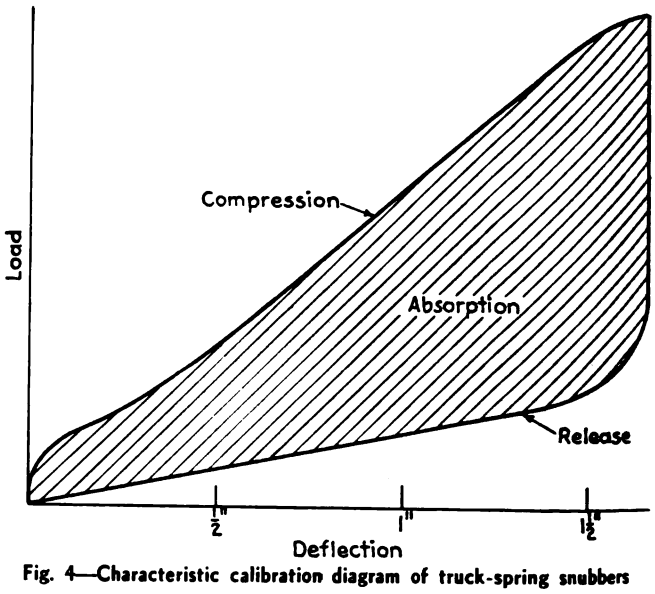


Fig. 4—Characteristic calibration diagram of truck-spring snubbers

or empty-car bodies bounce or jiggle around on top of these stiff springs like cigar boxes. Stiff spring groups approach the effect of a solid block when the load on them is not great enough to produce a sufficient spring action.

A fully loaded 50-ton freight car is designed to carry a dead load of about 39,250 lb. on each spring group. When the car is empty the load on each group is approximately 8,000 lb. This is a difference of nearly 500 per cent. It makes the problem of using an all-coil spring group a most difficult one, as it is practically impossible to build up an all-coil group that will prevent the frequent recurrence of solid blows when the car is loaded and at the same time be soft enough to keep from damaging light, fragile loads and loosening up the car body when it is empty.

The first efforts in the direction of increased spring capacities were founded on the assumption that spring groups had to be designed to take blows of certain magnitudes. However, as investigations proceeded, greater attention was directed to the fact that it was only when

trains were being operated at certain speeds that increased capacity was necessary and that at lesser or greater speeds the same car rode smoother and the spring groups did not go solid. This suggested an analysis of the action of the spring groups at these particular speeds to determine if something could be done to reduce the magnitude of the blows and this analysis was the beginning of the development which has led up to the use of the freight-car truck-spring snubber.

Before we go any further, it is interesting to note that the fundamental difficulties that initiated these investigations were excessive spring breakage and high maintenance cost and not damage claims, as some of us might think. Unquestionably, damage claims were a contributing factor but maintenance costs were the original in-

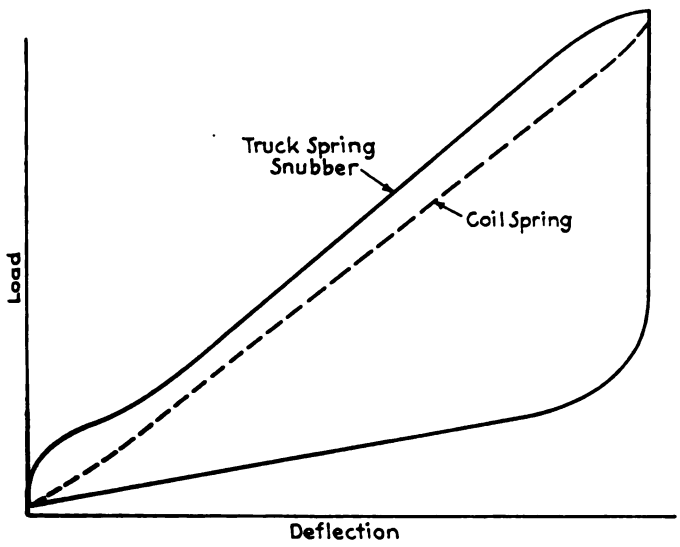


Fig. 5—Comparison of calibration diagrams of a coil spring and a truck-spring snubber

centive and we believe they are today the biggest reason why truck-spring snubbers should be used under all kinds of freight cars.

Characteristics of Coil Springs and Truck-Spring Snubber

The coil spring, when it is compressed, stores up energy. It does not dissipate it. When it is released it gives back practically all of the energy, or force, that was required to compress it. Fig. 1 shows a calibration curve of a standard A. A. R. 1936 spring. As this spring is compressed the force required to compress it through each ½ in. of its travel between its free and its solid height is the same. In other words, it does not take any more force to close it the last ½ in. than was required for the first ½ in. That is the reason that its compression characteristics are represented by this straight line. As the spring is released, it gives back the same pressure in each ½ in. of its travel that was required to compress it that amount, which means that its release characteristics are represented by this same straight line. This is the basic feature of coil-spring action.

When you drop a weight on a coil spring it vibrates up and down just like a punching bag vibrates back and forth when you hit it. In 1933 the Mechanical Division of the A. A. R. conducted a series of tests of trucks and truck springs designed to permit easier riding and reduce harmonic action. Fig. 2 is a reproduction of a curve that was developed in these tests. It shows how coil springs deflect and continue to vibrate when a weight is dropped upon them. You will notice how the spring group bounces up and down until the vibrations finally die out just like a punching bag. These regularly continued vibrations are called harmonic action.

Fig. 3 shows a curve that we have constructed to illustrate a point. In making it, we have assumed that, first, a weight is dropped on a coil spring to start it vibrating. Then, at every fourth vibration an additional blow is delivered to the spring in time with the vibrations and in the same direction. It is obvious what happens. The additional blow simply adds to the length of the natural vibration set up when the weight was dropped on the spring and when the amplitude of every fourth vibration is increased in this way there is a build-up that increases the magnitude of the vibrations out of all proportion to what would be produced by any one of the blows. What actually happens to a coil spring when it is given successive blows like this in time with its natural vibration is that it goes solid and, of course, it only goes solid so many times before it breaks.

Similarly, when a group of springs carrying a certain load under a freight car is subjected to a blow, the springs begin to vibrate up and down. Then, if another blow is delivered to the spring group at just the right time it builds up the vibrations and it doesn't take many more blows delivered at just the right time to build them up to the extent that the springs go solid. This does happen to freight cars and the speeds at which it happens are called "critical speeds." The regular blows that are delivered to the spring group are due to the rail joints which the trucks pass over. Of course, the rail joints are evenly spaced and this action takes place when the blows from the rail joints are in time with the natural vibration of the springs. Out-of-round wheels and other track irregularities will produce the same rhythmic effect and when two or more of these conditions act in harmony with each other the combined effect is more severe.

A car carrying a given load has several different critical speeds. In this diagram we have assumed that additional blows are delivered to the spring every fourth vibration. We might have assumed that the blows were delivered every third or fifth vibration. Had we done this, we would have increased or decreased the rapidity with which the blows are delivered and, of course, increased or decreased the rate at which the amplitude of the vibrations build up. Different freight-train speeds produce this difference in the time rate of delivery of

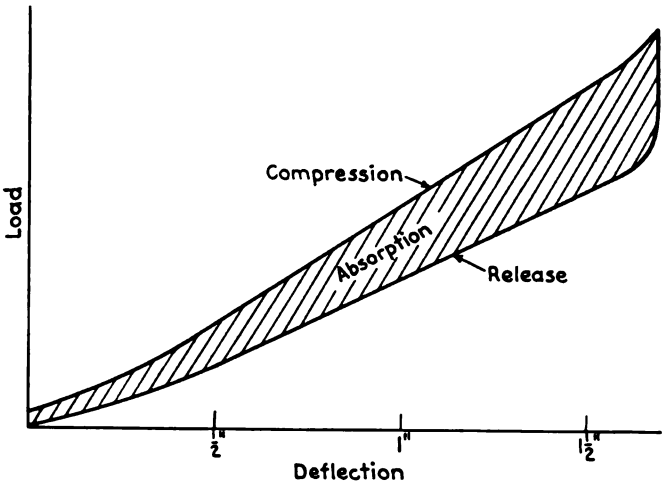


Fig. 6—Characteristic calibration diagram of a combination group consisting of a truck-spring snubber and coil springs

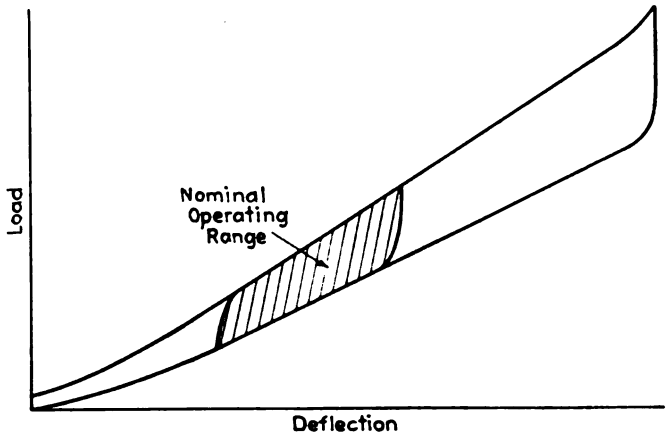


Fig. 7—Nominal operating range of a combination coil spring and truck-spring snubber group under a partially loaded car

blows and build up, which you can readily see is responsible for different critical speeds.

When a car is operated at a critical speed, and particularly at the higher critical speeds, it bounces up and down or oscillates most violently. Sometimes the action is severe enough actually to lift the bolster off of the spring seats. There is not a fine hairline difference between critical and non-critical speeds. Each critical speed is the center of what is termed a "critical speed range" which includes speeds that will vary from three to five miles per hour on each side of the exact critical speed. Usually springs go solid and cars always ride very roughly whenever the speed is within any critical range.

Truck-spring snubbers possess some characteristics that are vastly different from those of coil springs. When a truck-spring snubber is compressed, it not only absorbs energy, but it dissipates it. It differs from a coil spring inasmuch as it does not store up all of the energy that is delivered to it. Therefore, when a truck-spring snubber is released it does not give back the same amount of energy or force that was required to compress it.

Fig. 4 shows a characteristic calibration curve of a truck-spring snubber. Now this paper was prepared by a number of manufacturers of truck-spring snubbers. This curve does not illustrate the details of the action of any particular snubber but does show the general characteristics that are common to all of these truck-spring snubbers. The top line is the compression line. It indicates the amount of force that is required to compress the snubber through any given portion of its travel. The lower line is the release line. It indicates the pressure that the snubber gives back when it is released. The shaded area between the two lines represents the amount of work that is put into the snubber and not given back or, in other words, this represents the amount of energy that is dissipated. All truck-spring snubbers employ friction generated in one way or another as the means for dissipating energy.

Fig. 5 compares the calibration curves of a coil spring with the characteristic calibration curve of a truck-spring snubber. It illustrates the difference in the compression and release characteristics of these two devices. The broken line shows the coil spring characteristics. It gives back the same force at the same rate that it stored it up. The solid line represents the action of a truck-spring snubber. Its compression and release characteristics are different. It would not function as a snubber if they were not. The real reason for designing a snubber that will give back any force at all when it is released is to insure a positive release and make sure that the follower wedges will always remain against the spring seats on the up stroke of the spring group.

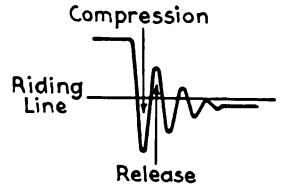


Fig. 8—Bounce test with 27,000-lb. drop weight of old standard A. R. A. coil springs and truck-spring snubbers

Fig. 6 is a characteristic calibration diagram of a spring group consisting of coil springs and a truck-spring snubber. This shows the effect on the group of the dissipation of energy by the snubber. As in Fig. 5, the upper line is the compression line, the lower line is the release line, and the shaded area between the two represents the absorption of the group. This is a calibration which covers the total deflection of the group. It charts the deflection characteristics throughout the entire travel between free and solid heights.

Fig. 7 shows the compression and release characteristics of the same group through a nominal working range. Combination snubber and coil-spring groups are never deflected through their entire range while in actual service. When carrying normal loads at normal speeds, the actual deflection range of the groups rarely exceeds ½ in. The shaded area and its boundaries indicate the compression, release, and absorption characteristics of the group acting through a nominal deflection range.

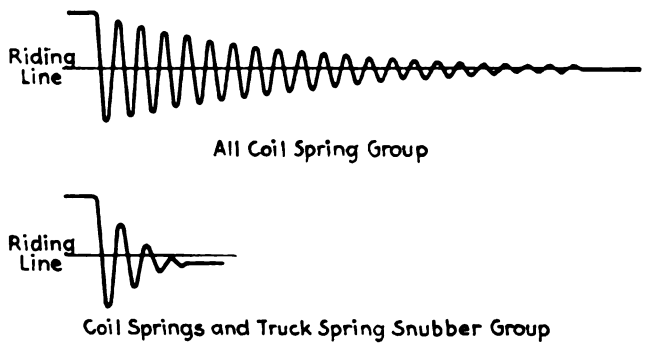


Fig. 9—Comparison of the bounce tests of all-coil spring group and the group consisting of a truck-spring snubber and coil springs

Fig. 8 is a bounce test diagram of a combination coil-spring and truck-spring snubber group. This is also a copy of one of the tests made by the Mechanical Division of the A. A. R. in 1933 in connection with the tests on trucks and truck springs designed to promote easier riding. It shows how a truck-spring snubber dampens out coil spring vibration or harmonic action. In doing this it prevents the build-up of violent spring action from one rail joint to the next and, because it prevents this violent action, it reduces the coil spring capacity required to prevent the spring group from going solid. This is an important fact and must be taken into consideration if the best light car riding characteristics are to be developed.

For all-coil spring groups the A. A. R. recommends a minimum coil capacity of approximately twice the maximum static load that will be carried by the spring group. Where truck-spring snubbers are used in combination with coils, the coil capacity can safely be reduced to less than one and one-half times the maximum static load that the spring group will carry. This, of

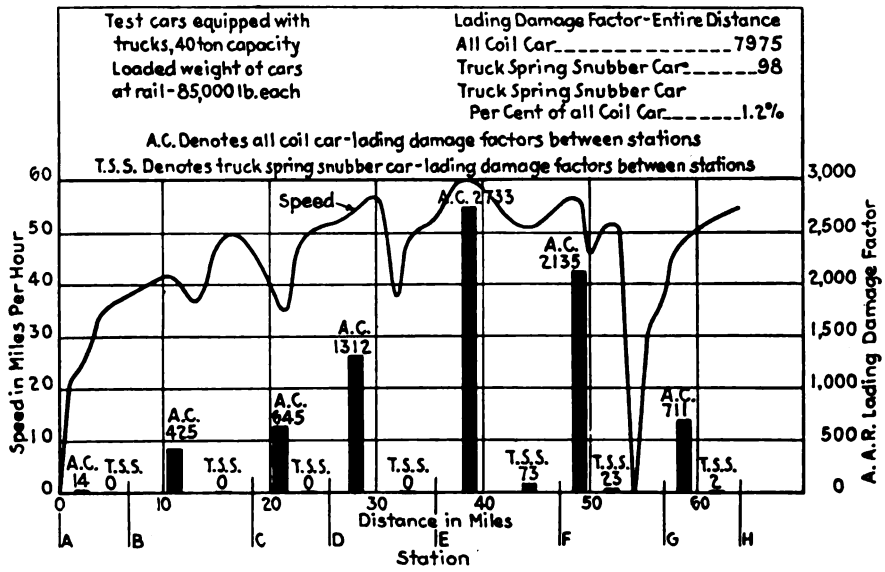


Fig. 10—Comparison of riding characteristics of all-coil spring groups and combination truck-spring snubber and coil-spring groups

course, makes a softer spring group and one that is much better suited for the operation of an empty or lightly loaded car.

Fig. 9 compares the bounce test of coil springs with the bounce test of a combination coil spring and truck-spring snubber group. It shows how a truck-spring snubber breaks up the harmonic action of coil springs and in so doing prevents the build-up that makes springs go solid. By damping out so many coil-spring vibrations, it greatly reduces the wear on the columns of the side frame. This goes as far as laboratory demonstrations can to show the value of truck-spring snubbers.

Fig. 10 shows a much more practical example of their value. It shows the results of a comparative road test of a car equipped with all-coil spring groups and another car equipped with a snubber-coil spring combination. The test was conducted over 62 miles of main-line track passing stations *A*, *B*, *C*, *D*, *E*, *F*, *G*, and *H*, as shown. The top line indicates the speeds at which the test train was operated. The columns marked *AC* and *TSS* indicate the lading-damage factors that were developed in the respective test cars between each of the stations. *AC* denotes the all-coil spring group car and *TSS* the truck-spring snubber equipped car. You will note that between stations *E* and *F* the all-coil car developed a lading-damage factor of 2,733, while the truck-spring-snubber car only developed a lading damage factor of 73. A lading-damage factor represents the number of blows and the intensity of the blows that are delivered to a car body as measured by instruments that are specially designed for this purpose. The instruments used in this test are exactly the same as those that have been used by the Association of American Railroads in their riding-quality tests and the lading-damage factors were determined by the use of the same formula that the Association of American Railroads uses. It is interesting to note that the lading-damage factor developed by the truck-spring snubber equipped car over the entire distance was only 1.2 per cent of the lading-damage factor developed in the car with all coil-spring groups.

Fig. 11 shows a comparison of the riding characteristics of 50-ton coal cars equipped with all-coil groups and combination truck-spring snubber and coil-spring groups. These results were obtained on another railroad by the use of an instrument that graphically records the oscillations of the carbody which can be interpreted in terms of the magnitude of the blows delivered through the spring groups. You will note that the forces delivered to the spring group of the snubber-equipped car were never sufficient to close this group. In fact, due to the dampening action of the snubber, there always remains an additional reserve capacity of at least 19,000 lb. over the most severe blow that the group had to absorb.

(*Continued on page 189*)

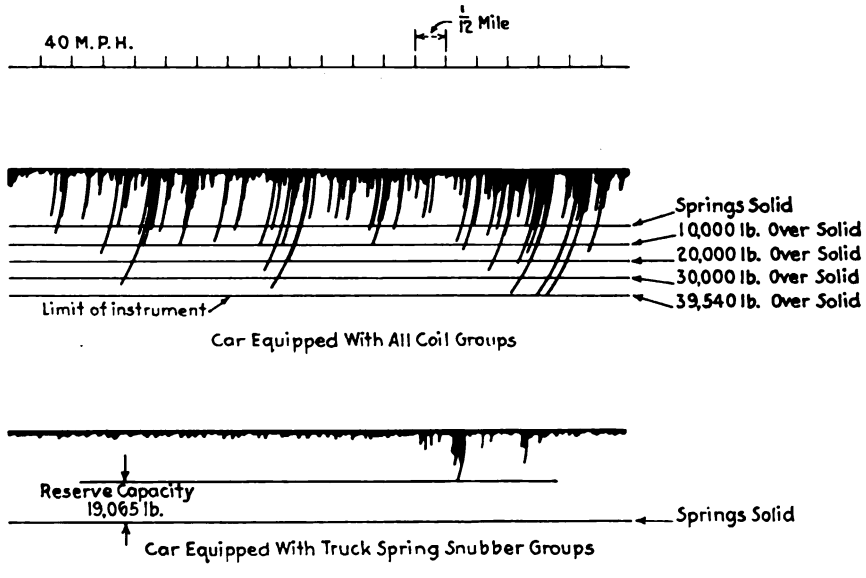
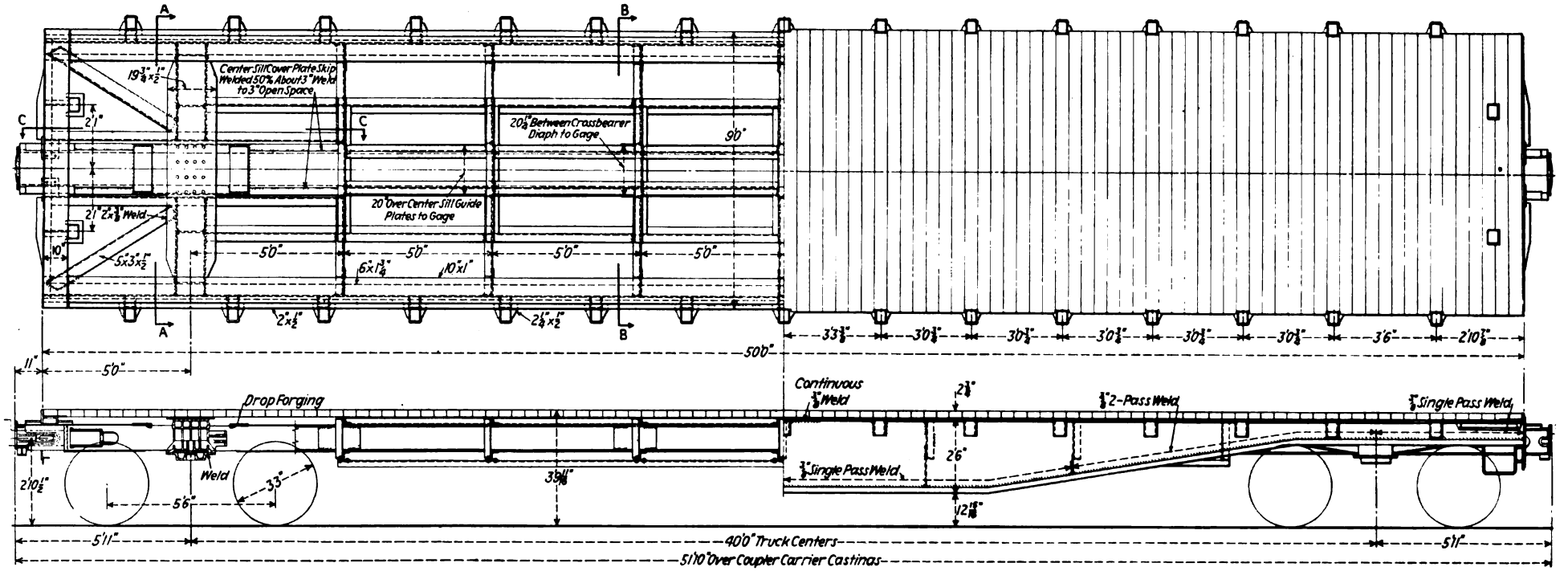
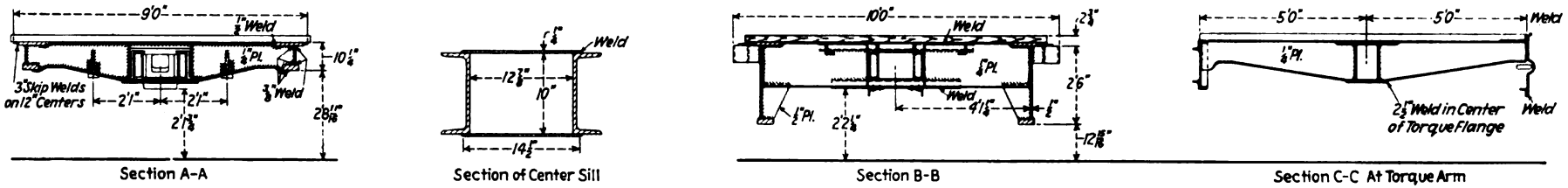
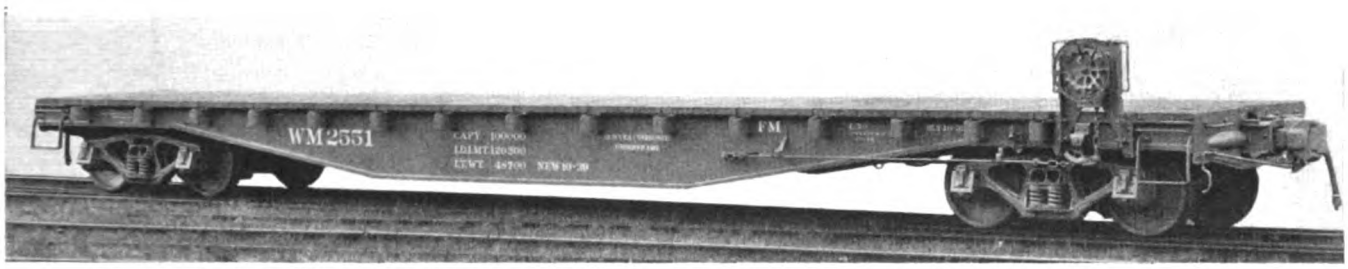


Fig. 11—Comparison of the riding characteristics of 50-ton coal cars; one equipped with all-coil spring groups and one equipped with coil-spring and truck-spring snubber groups





Sectional plan, elevation and cross-sections showing welding details of Western Maryland all-welded flat cars



Western Maryland

All-Welded Flat Cars

These cars for general flat-car service are equipped with the Duryea cushion underframe and have an unusual hand-brake arrangement to facilitate the loading of the cars

THE Western Maryland has recently placed in service ten 50-ton flat cars of all-welded construction built by the Greenville Steel Car Company. The cars have a length of 51 ft. 10 in. over the coupler carrier castings and a light weight of 48,700 lb. They are equipped with the Duryea cushion undeframes which, besides affording more than normal protection to the car body and lading, permits them to be utilized in twin-load service without blocking out the draft gears between the cars. The Ajax hand brakes are applied to a hinged support on the sides of the cars and can be dropped to a position in which they will not interfere with the loading of the cars over the sides.

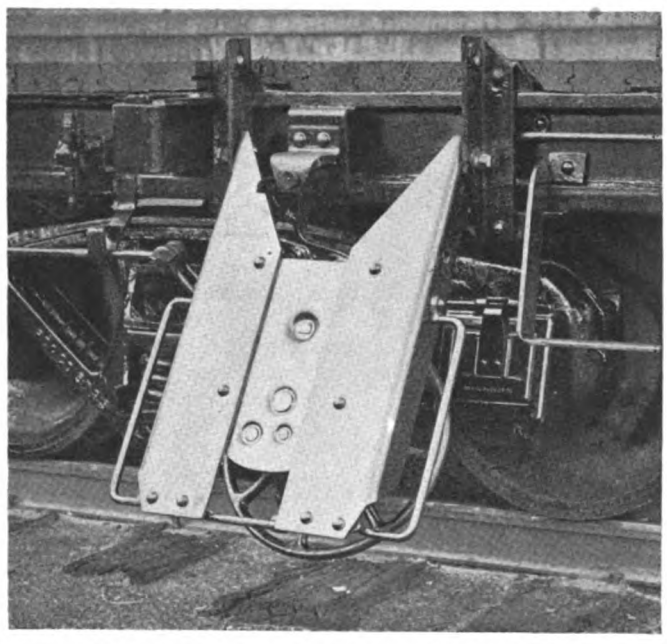
The center sills are of box girder design consisting of two 10-in. channels with ¼-in. top and bottom cover plates, skip welded to the channels, which extend to within a distance of 7-in. from stop faces on the bolsters. Drop forgings have been welded to the bolster end of the top cover plates to serve as stops to limit the movement of the cars with respect to the center sills. Vertical plates, ⅜ in. by 9 in. by 4 ft., are welded to the outsides of the channels where they pass through the bolsters.

The side sills are designed to carry the entire load. They are built up with horizontal top and bottom members to which a vertical web plate has been welded. The top member is of 1-in. by 10-in. plate and is welded to the web plate by ⅜-in. continuous welds on both sides. The bottom member is of 1¾-in. by 6-in. plate and is welded to the web plate by both ⅜-in. single-pass welds and ⅜-in. two-pass welds as indicated on the drawing.

The bolster construction is essentially of A. A. R. design except that it is welded throughout and has a cast-steel center brace to carry the movable center sill. The horizontal top member of the bolster is of ½-in. by 19¾-in. plate, the bottom member is of $^{11}/_{16}$-in. by 14-in. plate, while the vertical members are of ¼-in. plate.

There are seven cross-bearers, each consisting of a pressed diaphragm with 3-in. Z-bar members at the top and bottom welded into a single unit and to the side sills. They are formed with an opening of 20¼ in. at the center to permit the movement of the center sill. Along the top and bottom of the diaphragms are welded 3-in. Z-bars. The cross-bearers have supports of ½-in. plate welded to the bottom horizontal member, to the inside of the side sills, and to the diaphragms. The cross-bearers are all tied together with continuous longitudinal angles, one under each center-still channel, which are riveted to the bottom flanges of the diaphragms.

Diagonal braces of 5-in. by 3-in. by ½-in. plate to the corners of the car are welded to the top horizontal member of the bolster and to the end and side sills. Four lines of Z-bar floor supports are welded between the bolsters and the diaphragms and extend from bolster to bolster. The cars have 2¾-in. oak flooring for greater strength and to furnish a surface suitable for the application of blocking. The welding throughout the car is of ¼-in. welds unless otherwise noted on the drawing.



The Ajax hand brake may be swung to a position that will not interfere with loading over the side

The Causes and the Prevention of

Embrittlement in Boilers*

By W. C. Schroeder†

Investigation shows a combination of four conditions must exist simultaneously to produce embrittlement—Chemical treatment—The use of the embrittlement detector

EMBRITTLEMENT cracking in the riveted seams of locomotive boilers has been encountered and definitely identified on a considerable number of American railroads. It is probable that in some slight degree, and perhaps without identification as embrittlement, the trouble has been met on many railroads. It is, of course, difficult to arrive at figures for replacement costs on embrittled locomotives, although this has recently been estimated at $500,000 per year. These costs are probably of secondary importance in comparison with the desire to keep the locomotives in the best condition for service.

This situation has led to an intensive investigation of the embrittlement problem that has been generously supported by the Association of American Railroads, by several of the leading engineering organizations, and by the private industry, and by the Bureau of Mines.‡ From the study has come a coherent explanation of the process and the factors that allow embrittlement to occur in a riveted seam, devices that, attached to a locomotive, will determine whether or not the water can cause cracking, and chemical methods for feedwater treatment to make the water non-embrittling.

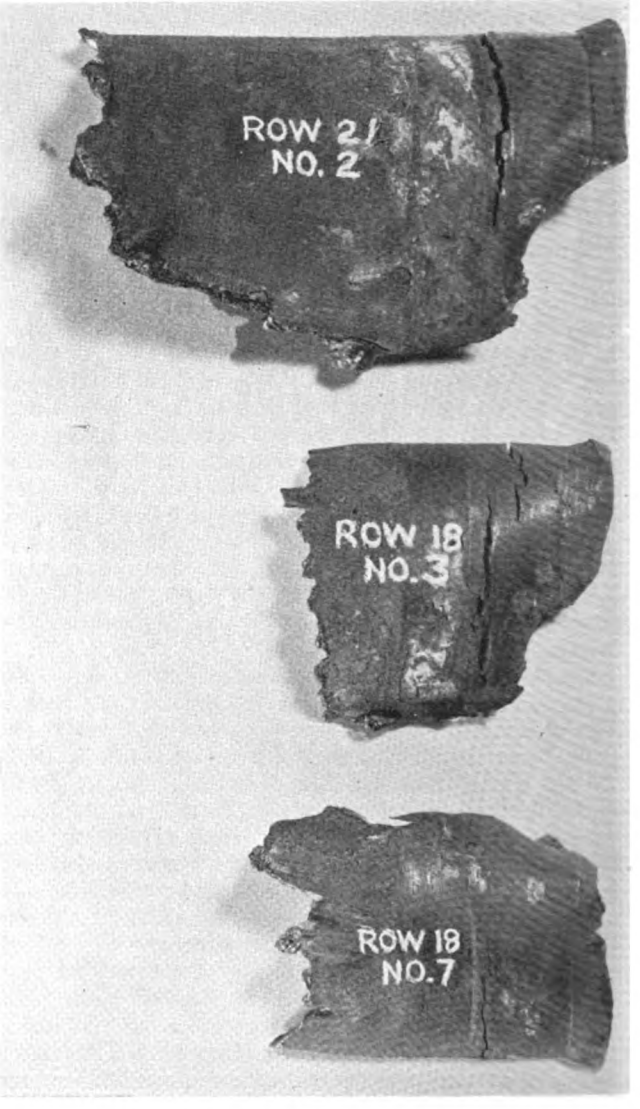
For many years the mechanism that allowed a solution to produce embrittlement or intercrystalline cracking was a profound mystery. Details are still not clear, but an explanation can be offered that will fit the experimental facts now available.

Chemical Action and Stress Must Be Present

It is well known that in many service conditions, steel will corrode or rust and that under more limited conditions this rusting will occur only at restricted points to produce deep holes or pits. Steel is made up of crystals held together by thin bands of material designated as grain boundaries and these boundaries are known to have different chemical properties from the crystals. Therefore, certain corroding solutions may exist that, instead of causing a random distribution of holes or pits over the metal surface, will confine all the attack to the grain boundaries, separating the crystals from each other and eventually allowing the metal to fail. As a very crude illustration, the action might be likened to the removal of the mortar from between the bricks in a wall, allowing the structure to collapse.

It is unfortunate that the very solutions that have been found most desirable in a boiler from the standpoint of preventing the rusting and pitting of the tubes and drum are the very ones most prone to cause embrittlement in the riveted seams. It is, therefore, desirable in many cases to establish the necessary conditions to prevent pitting and then add chemicals to prevent embrittlement.

Unlike rusting and pitting, however, embrittlement seems to occur only when the metal is under stress, and mainly stress in tension. These stresses arise from the structural load, from the steam pressure, or from cold work of the metal. Laboratory study indicates that this latter factor is of the utmost importance. The cold bending of a sheet to form a locomotive drum will at times introduce enough work stress to make embrittlement attack possible. Cold distortion of the metal during riveting of a seam may be even more severe.

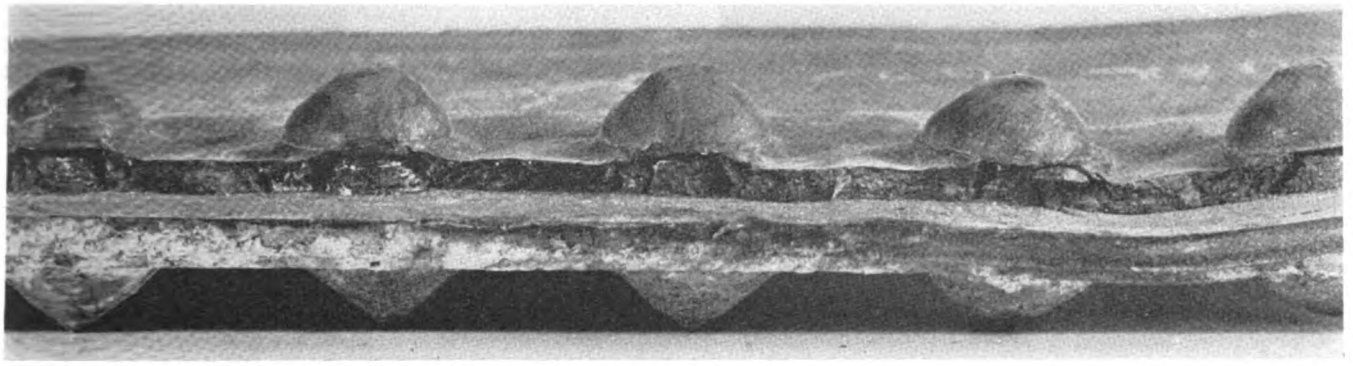


Embrittled tube ends from a watertube boiler

* An abstract of a lecture delivered before the annual meeting of the Master Boiler Makers' Association at Chicago on October 17, 1939, and published by permission of the Director of the Bureau of Mines.

† Senior chemical engineer, Eastern Experiment Station, Bureau of Mines, College Park, Md.

‡ An abstract of a report of the earlier investigation of this problem by the Bureau of Mines was published in the September, 1938, issue of *Railway Mechanical Engineer*.



Edge view of embrittled lap joint of caustic settling tank

To prevent embrittlement, the pressure and structural stresses in the seam should not be excessive and all possible care should be exercised to see that they are not localized, for a crack may be started from one point that will be difficult to stop. Above all else, however, the cold working of the drum, butt strap, and rivet metal should be kept at a minimum.

The author believes that careful design and fabrication of locomotive boilers can prevent a large portion of the cracking in spite of bad water conditions.

Concentration of the Boiler Water in the Riveted Seam

Contact of a normal locomotive boiler water with the riveted seam will not cause intercrystalline cracking. If there is a slight leak through the seam, deposits of solids are frequently seen at the outer edge and, when the seam is torn apart, are found between the drum sheet and butt straps as well as around the rivets. To create such deposits, which are made up of the so-called "soluble salts," the boiler water must concentrate several hundred fold. This concentrated solution in contact with the stressed metal is the one that causes embrittlement.

To produce concentration in this manner the leak must be very slow. One that can just be detected through the formation of a very faint haze of steam on a cold mirror held over the point of leakage is very dangerous. Such leaks are so small that they may not be detected during a cold pressure test on the locomotive.

A boiler that shows deposits of white solid at the seam edges may be in serious danger of embrittlement. Fabrication should make the drum just as tight as possible, for it is the speaker's belief at the pesent time that intercrystalline cracking cannot occur in a locomotive boiler in the entire absence of leakage.

The Embrittlement Detector

The embrittlement detector, a very simple device for direct attachment to a locomotive, has been developed to measure the embrittling action of the boiler water. The water circulates through a block, to which a specimen is clamped and a slow leak creates concentrated solution in contact with the stressed area of the specimen. If the water is embrittling, the specimen will crack. When this occurs, chemical treatment is added to the feedwater and the test repeated to prove that the water is non-embrittling. These devices are now in use on a number of railroads throughout the United States.

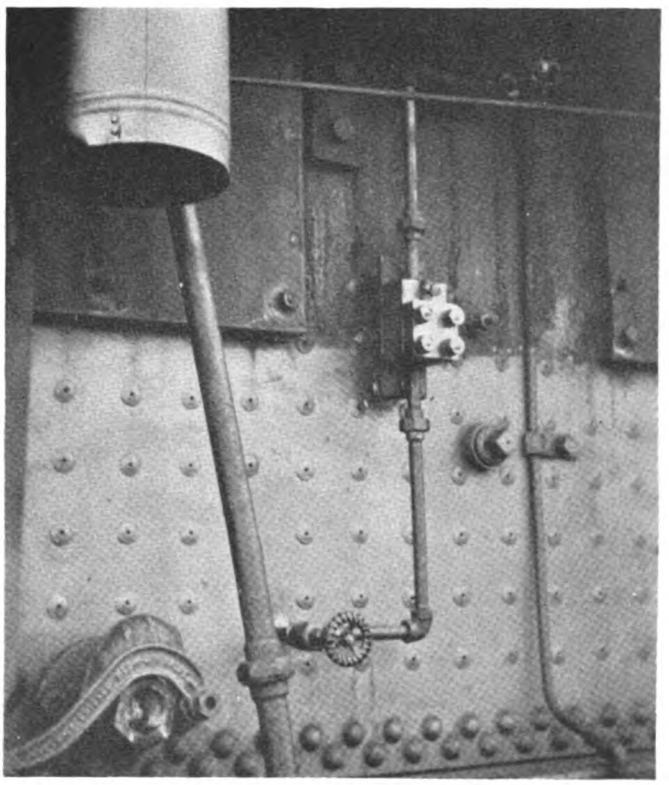
Combination of Four Factors Required for Embrittlement

Intercrystalline or embrittlement cracking is not due either to water conditions or boiler construction alone, but to a combination of factors that simultaneously create the following conditions: (1) A boiler water which, when concentrated, will produce embrittlement or intercrystalline cracking; (2) high stress in the metal, which may result either from cold work or externally applied stress; (3) formation of a film of concentrated solution as a result of slow leakage and (4) contact of the film of concentrated solution with the boiler metal in the region of high stress.

The first factor is in partial control of the chemist, the second probably depends on the design and workmanship used in the boiler construction, the third depends on the design and construction as well as conditions of service, while the last one would seem to be pretty much in the hand of fate.

Protection From Embrittlement

It should be possible to prevent embrittlement by eliminating any one of the four factors that have been listed. On locomotives already built and in service, the simplest and least expensive remedy seems to be water treatment. In the past, successful pursuance of this course has been impossible because of incomplete and, at times,



Embrittlement detector installed on a locomotive boiler

totally wrong information concerning embrittlement. Even at the present, feedwater-treating methods, while apparently successful, are still in the experimental stage. Fortunately, it is now unnecessary to wait until a locomotive boiler cracks to designate a water-treating method as ineffective, for a test run with the embrittlement detector will crack a specimen and give warning of dangerous conditions in a short time.

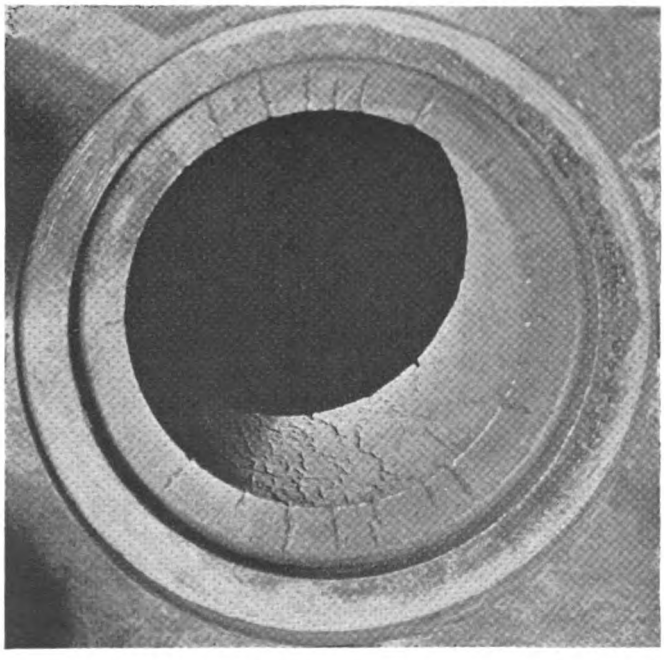
While water conditioning may prevent embrittlement, this offers not the slightest excuse for poor boiler design and bad workmanship that provides the other necessary conditions to start and promote cracking. In every case of embrittlement cracking, the boiler manufacturer should be willing to assume and shoulder his full responsibility where poor design, bad shop practices, or poor workmanship are evident.

The investigation at the Bureau of Mines has been so far largely confined to the study of chemical methods for treating the feedwater to prevent embrittlement. Some engineers have thought that sodium sulphate was satisfactory for this purpose, but this idea is not substantiated by laboratory work, nor apparently by railroad experience. A few organic chemicals have been found, however, that seem to be satisfactory protective agents.

The Use of Sodium Sulphate

As a result of a statistical study of stationary boilers, the conclusion was reached by a few engineers that maintenance of certain amounts of sodium sulphate in a boiler water would prevent embrittlement. A subcommittee of the Boiler Code Committee of the American Society of Mechanical Engineers later adopted this idea as the basis for the embrittlement code, in spite of the fact that the railroads had submitted statements indicating that their experience was apparently in disagreement with this belief.

In the past, a tendency has existed to interpret evidence from stationary boilers largely with the idea that if a water was embrittling the boiler would crack. Therefore, if an alkaline boiler water contained sodium sulphate and the boiler did not crack, this was taken as partial evidence that the sodium sulphate rendered the water non-embrittling. When applied to an individual case the present and clearer understanding of the embrittling problem makes apparent the fallacy of such reasoning. Even though the water is embrittling, the boiler will not crack unless simultaneously it develops, (1) leaks of just the right size to allow concentration to take place, (2) if certain areas of the boiler metal are highly stressed, and (3) if the stressed metal is in contact with the concentrated solution. Therefore, if the boiler does not crack this does not necessarily mean that sodium sulphate is protective, but may just as well mean that the boiler was well built and cracking would not have occurred in the entire absence of sodium sulphate.



External appearance of cracks believed to result from corrosion fatigue

It is certain that several factors are involved in the cracking of a boiler drum aside from the condition of the water. Therefore, it is going to be difficult, if not impossible, to isolate the effect of a given feedwater treatment in preventing cracks from a simple study of statistics on operating boilers. By use of the embrittlement detector, the cracking action of the water alone can be determined. Up to the present time even high concentrations of sodium sulphate have not stopped cracking of detector specimens in laboratory or plant tests.

Straub* has recently suggested that sodium sulphate and sodium chloride prevent embrittlement. Plant and laboratory tests with the embrittlement detector have not confirmed this idea at all.

The Use of Organic Materials

Extensive study has not yet revealed any inorganic compounds which are definitely without undesirable properties in a boiler and which at the same time will prevent embrittlement. Therefore, search for a material with these desirable properties has been made in the field of organic chemicals, with some degree of success.

In the pressure range normally used in locomotive operation, lignin-containing materials, as represented by waste sulphite liquor,†, will prevent cracking in detector specimens of boiler flange steel. Waste sulphite liquor is not expensive and its use on a considerable number of railroads has shown that it creates no operating difficulties. In several cases its effect on the embrittling action of the water is being closely followed with detectors attached to the locomotives. Practical tests of this type will furnish data of the utmost significance.

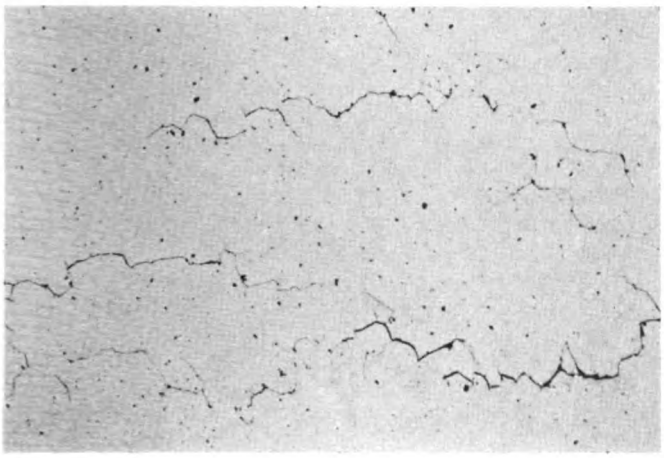
One American railroad, during the period 1912 to 1926, reported 221 engines cracked through embrittlement. In this latter year, lignin compounds were introduced into the feedwater in conjunction with an antifoam treatment. A decrease in cracking was noted and the treatment has been in continuous use since that time. From 1926 to 1938 only eight cases of engine cracking have been reported. At the present time the road is entirely free from difficulty and in view of the fact that laboratory tests show the lignin to be a good protective agent, it may be reasonable to assign the major portion of the improvement to the use of this compound. The author hesitates, however, to cite statistical evidence of this type since it is obvious that over a period of years, many changes might have been made aside from those in water conditioning. This whole case could be made a good deal clearer by the use of the embrittlement detector to determine the action of the waters before and after lignin treatment. It is hoped detector tests now under way on other railroads will demonstrate less equivocally the action of the lignin compounds.

Quebracho, another organic compound, has been found suitable in the laboratory for preventing intercrystalline cracking over the pressure range from 200 to above 500

* F. G. Straub and T. A. Bradbury. Boiler Water Treatment New Methods for Preventing Embrittlement. Mechanical Engineering, pp. 371-376, May, 1936.

† A waste product from the paper industry.

lb. It is effective not only in boiler flange steel but also in specimens that have been cold worked before insertion in the detector. In general, it is probably too expensive for use in locomotives, but it has been extensively applied in stationary boilers. Coupled with a powerful effect in preventing embrittlement it will also remove oxygen from the boiler water and apparently



Unetched photomicrograph of intercrystalline cracks

exert a marked dispersing action on solid particles precipitating in the boiler water.

In the past, one of the foremost objections to the use of organic material has been the lack of a chemical test for determining their concentration. This has been overcome by the development of a fairly rapid colorimetric method that may be used to estimate lignin-containing materials such as waste sulphite liquor as well as quebracho, and several other similar organic compounds. This method has greatly helped in the intelligent application of organic treatment for preventing embrittlement.

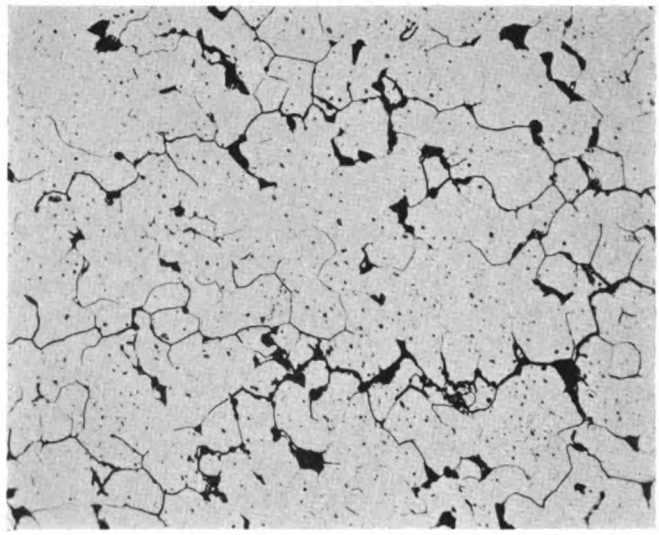
Conclusions

This lecture has attempted to develop, on the basis of information now available, a logical view point for the entire process leading to embrittlement cracking. The fundamental chemistry of the attack depends on the preferential corrosion of the grain boundaries with respect to the crystals of the metal, but it should be noted that stress is apparently a necessary prerequisite to produce dangerous cracking. Embrittlement is not caused by contact of the metal with a dilute boiler water but instead by contact with a solution resulting from concentration of the water as it leaks and permeates through the riveted seam.

For embrittlement to occur in a locomotive boiler, combined conditions must exist as follows: (1) an embrittling water, (2) high cold-work or applied stress in the metal, (3) leakage or concentration in the riveted seam, and (4) contact of the concentrated solution with the stressed metal.

These factors clearly indicate that only a portion of the problem is in the hands of the feedwater-treating chemist. The boiler manufacturer must bear his responsibility to see that design and cold work stress are kept to a minimum and that the seams are so constructed that they can be maintained essentially "leak free."

At the same time, since the embrittling or non-embrittling nature of the water is only one factor in the problem, it becomes difficult to interpret statistical data



Etched photomicrograph of intercrystalline cracks

from operating boilers to determine the effectiveness of a given chemical treatment in preventing cracks. This may indicate that incorrect interpretation has been applied to the cases which were believed to indicate that sodium sulphate would stop cracking. The old contention of several of the railroads that this salt was not satisfactory in locomotive boilers may then be correct, and furthermore is logical, since railroad observations are based on so many more units that the chances are much better for obtaining the combined conditions to favor cracking that will show the ineffectiveness of a given treatment. For instance, two railroads in the United States that have suffered most severely from embrittlement have a combined total of more than 3,000 locomotive boilers on which to base their observations. Individual cases of cracking will run well over 500 with approximately 400 engines involved.

The costly and undesirable method of measuring the ineffectiveness of a given treatment to prevent embrittlement by allowing a locomotive boiler to crack is perfectly apparent. Now, the evidence points strongly that this can be avoided by direct attachment of an embrittlement detector to the locomotive. At the same time, this unit will make it possible to classify the embrittling action of boiler waters, without introducing variables of boiler construction. To date, tests have not shown that sodium sulphate will stop cracking.

No inorganic salt or combination of inorganic salts has yet been found entirely suitable for use in the boiler to prevent embrittlement. Organic materials such as waste sulphite liquor and quebracho are apparently much more successful. At the present time the waste sulphite liquor seems most suitable in locomotive operation. A method of analysis has been developed to determine its concentration in the boiler water.

Present evidence indicates that waste sulphite liquor, found satisfactory for preventing embrittlement in the laboratory, may also have played a major part in the last 12 years in eliminating embrittlement on one railroad suffering from this problem in a most aggravated state. A second railroad has been using the material under controlled conditions for over a year with the evidence beginning to indicate a definite decrease in cracking.

With further laboratory testing as well as cooperative testing with the railroads, it is hoped to eliminate completely the embrittlement problem from railroad operation.

Illinois Central Builds Three

Heater Cars*

By H. Anderson†

THREE heater cars were constructed at the Illinois Central Burnside Shop, Chicago, in February for use in connection with the Diesel-electric switch engines, none of which is equipped to furnish steam to passenger cars. The new heater cars will be used in the Diesel engine handling of trains at Central Station, Chicago, in the cleaning yard, and for the turn-around.

The three heater cars were numbered HU 1, HU 2, and HU 3. They are of steel construction, having been built from the underframes and trucks of retired express refrigerator cars. The underframes were reduced in length from 40 ft. to 30 ft., before the construction was begun.

Each of these cars is equipped with the following units: two rectangular steel water tanks, two rectangular steel fuel-oil tanks, two Clarkson steam generators, two fuel and water pumps, two 3-hp. motors, one ¾-hp. motor, one air compressor, one steam-engine-electric generator set, one battery unit, electrical equipment for automatic operation of the system, two sets of steam coils for heating the car, a water treating tank for eliminating scaling in coils, and a small rotary converter for the ignition system.

Two 3-hp. motors operate the fuel oil and water pumps which furnish fuel oil and water to the boilers, also the blower fans. A small air compressor, operated by a ¾-hp. motor, furnishes 22 lb. pressure, which atomizes the fuel oil. The fuel is supplied from two tanks, 1,000 gal. total capacity, located at one end of the heater car.

The water is supplied from two tanks, total capacity of 4,500 gal., located in the opposite end of the car and to the sides, allowing passageway through the center of the car. The water from these tanks, which are connected with balancing pipes so that the water level is maintained equal in each tank, flows through the treating tank before entering the boilers. The steam generators are capable of raising and maintaining 240 lb. steam pressure two minutes after starting, and evaporating 1,600 lb. rated capacity of water per hour each, or 2,000 lb. maximum each, both generators having a rated capacity of 3,200 lb. per hour and a maximum capacity of 4,000 lb. of steam per hour, which is sufficient to keep 20 to 25 passenger cars warm at sub-zero temperature.

The system is started by a unit of eleven Idex batteries, less one cell, or the equivalent of eleven automobile batteries, less one cell, or 62 amp. hour, 64 volt capacity. These batteries start the small air-compressor motor and the two 3-hp. motors operating the fuel and water pumps and fans. When 150 lb. of steam pressure has been raised, steam is admitted to a small one-cylinder reciprocating steam engine of 2,100 r.p.m., which runs at 7½-kw., 64-volt generator, which in turn operates the above mentioned motors, relieving the batteries and at the same time recharging them.

The exhaust from the steam engine is carried through a fin radiation line on top of car for condensation, thence back to water tanks, thus conserving the water supply and preheating the water for the boilers.

There is also installed at each side of the cars a steam coil for heating the car, which can be supplied from the boilers when in operation, or from a yard line when idle. The condensation from these coils also returns to the water tanks.

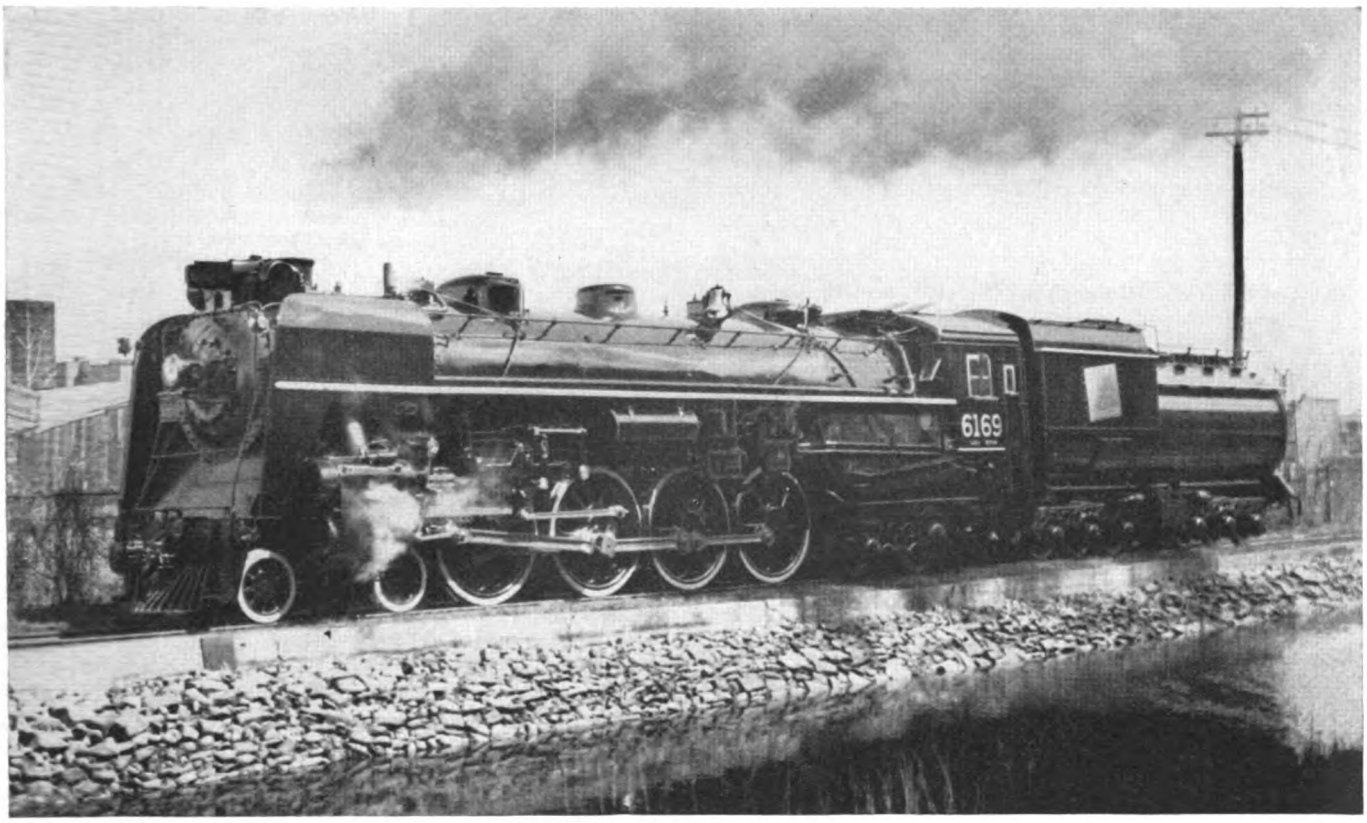
The piping system, steam, oil and water is installed inside of the car, with the exception of the steam train line under car, and the condenser, which is on top of the car. The entire system is installed, also, at a pitch, elim-

(*Continued on page 189*)

* Abstracted from the Illinois Central Magazine, April, 1940.
† Correspondent, Illinois Central Magazine.



Heater car built by the Illinois Central for use with Diesel-electric locomotives handling passenger equipment at terminals



Twenty-Five Improved Northern Type

4-8-4 Locomotives for C. N. R.

Locomotives for fast freight and heavy passenger service have tractive force of 56,800 lb.—Fifteen with boosters develop 10,300 lb. more

THE first of fifteen 4-8-4 locomotives equipped with boosters on the trailer trucks was delivered to the Canadian National on March 21 by the Montreal Locomotive Works, Ltd. Ten additional locomotives of the same design but without boosters are being built by the Canadian Locomotive Co., Ltd., Kingston, Ontario. The locomotives with the boosters are classified by the railroad as U-2-e's and have road Nos. 6165 to 6179, while those without boosters are U-2-f's and are assigned road Nos. 6180 to 6189.

These locomotives are similar in basic design to locomotives of the same type built for this railroad by the Montreal Locomotive Works, Ltd., in 1929. They have a maximum rated tractive force of 56,800 lb. with an additional 10,300 lb. developed by the locomotives equipped with boosters. All the locomotives have 73-in. drivers, 25½-in. by 30-in. cylinders, and the boilers carry a pressure of 250 lb. The total weight of the U-2-e engine is 402,700 lb. of which 240,800 lb. is carried on the drivers and of the U-2-f engine is 391,000 lb. with 238,000 lb. on the drivers. The locomotives have Baker valve gears with a 9-in. maximum travel. The U-2-e locomotives have a valve setting suitable for fast freight service while the U-2-f locomotives have a valve setting which makes them more adaptable for either fast freight or heavy passenger service. All of the locomotives are fitted with Barco type M-1 power reverse gears.

The tenders are of the Vanderbilt type having a capacity of 11,600 Imperial gallons of water and 20 tons of coal. The bottom of the tank is formed from a heavy plate which acts as the frame and to which are welded and riveted the draw and center castings. The stoker engine is housed in a compartment in the rear of the stoker trough which is of steel plate with cast-steel ends all welded into the tank structure. The tanks are carried on Commonwealth six-wheel trucks.

The boiler is of the straight-top type with three courses. The inside diameter of the first course is 80⅞ in., and the outside diameter of the largest course is 90 in. The firebox has a 48-in. combustion chamber and is equipped with two Thermic syphons and three arch tubes of 3-in. outside diameter. The boiler shell is made of silicon steel.

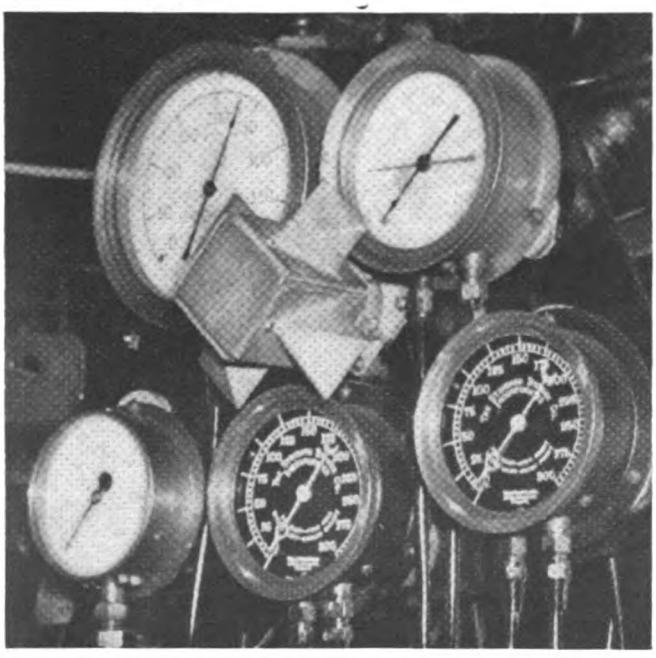
Improvements in Design

The design of the new locomotives has been modified to permit the installation of construction features which are regarded as improvements over the older locomotives of the same type. The steam passages to and from the

cylinders have been redesigned to remove restrictions to the flow of steam. Larger dry and steam pipes are employed, and the cylinders have been modified to obtain a more direct passage for the steam through steam and exhaust ports of greater area. The change in cylinder design has also made possible an increase in bolting surface between the cylinders and frames and between the cylinders and smokebox.

Table of Principal Dimensions, Weights, and Proportions of the Canadian National 4-8-4 Locomotives

Railroad	Canadian National	Canadian National
Builder	Montreal Locomotive Works, Ltd.	Canadian Locomotive Co., Ltd.
Type of locomotive	4-8-4	4-8-4
Road class	U-2-e	U-2-f
Road numbers	6165–6179	6180–6189
Service	Fast freight and passenger	Fast freight and passenger
Cylinders, diameter and stroke, in.	25½ × 30	25½ × 30
Weights in working order, lb.:		
On drivers	240,800	238,000
On front truck	67,800	68,800
On trailing truck	94,100	84,200
Total engine	402,700	391,000
Total tender	284,250	284,250
Total engine and tender	686,950	675,250
Wheel bases, ft. and in.:		
Driving	19–6	19–6
Rigid	12–8	12–8
Engine, total	43–10	43–10
Engine and tender, total	82–4¾	82–4¾
Wheels, diameter outside tires, in.		
Driving	73	73
Engine:		
Valve gear, type	Baker-Pilliod	Baker-Pilliod
Valves, piston type, size, in.	14	14
Maximum travel, in.	9	9
Outside lap, in.	1-5/16	1-9/16
Exhaust clearance, in.	3/16	3/16
Lead, in.	5/16	¼
Boiler:		
Type	Straight top	Straight top
Steam pressure, lb. per sq. in.	250	250
Diameter, first ring, inside, in.	80⅞	80⅞
Diameter, largest, outside in.	90	90
Firebox length, in.	126⅛	126⅛
Firebox width, in.	96¼	96¼
Combustion chamber, length, in.	48	48
Tubes, number and diameter, in.	42–2¼	42–2¼
Flues, number and diameter, in.	167–3½	167–3½
Length over tube sheets, ft-in.	21–6	21–6
Grate area, sq. ft.	84.4	84.4
Heating surfaces, sq. ft.		
Firebox	415	415
Tubes and flues	3,805	3,805
Evaporative, total	4,220	4,220
Superheater	1,884	1,884
Combined evap. and superheat	6,104	6,104
Tender:		
Type	Vanderbilt	Vanderbilt
Water capacity, gal.	11,600 (Imperial)	11,600 (Imperial)
Fuel capacity, tons	20	20
Trucks	6-wheel	6-wheel
Rated tractive force, engine, lb.	56,800	56,800
Rated tractive force, booster, lb.	10,300	....
Weight proportions:		
Weight on drivers ÷ weight engine, per cent	59.82	60.87
Weight on drivers ÷—tractive force	4.24	4.18
Weight on engine ÷ evap. heat. surface	95.4	92.7
Weight on engine ÷ comb. heat. surface	66.0	64.1
Boiler Proportions:		
Firebox heat. surface, per cent of comb. heat. surface	6.80	6.80
Tube-flue heat. surface, per cent comb. heat surface	62.34	62.34
Superheater heat. surface, per cent comb. heat surface	30.87	30.87
Firebox heat. surface ÷ grate area	4.92	4.92
Tube-flue heat. surface ÷ grate area	45.08	45.08
Superheat. heat. surface ÷ grate area	22.32	22.32
Comb. heat. surface ÷ grate area	72.32	72.32
Evap. heat. surface ÷ grate area	50.0	50.0
Tractive force ÷—grate area	673.0	673.0
Tractive force ÷ evap. heat. surface	13.46	13.46
Tractive force ÷ comb. heat. surface	9.31	9.31
Tractive force × dia. drivers ÷ comb. heat. surface	679.3	679.3



Arrangement of gages in cab illuminated by one light with reflecting guard

The application of SKF roller bearings has been made to all engine-, trailer-, and tender-truck axles. The main- and side-rod bearings have floating bushings on all the crank pins. Smoke deflectors of the side wing type have been installed on each side of the smokebox. Other features in which these locomotives differ from their predecessors include the use of the A. A. R. front-end arrangement and the application of a standard type HT stoker.

Special Equipment

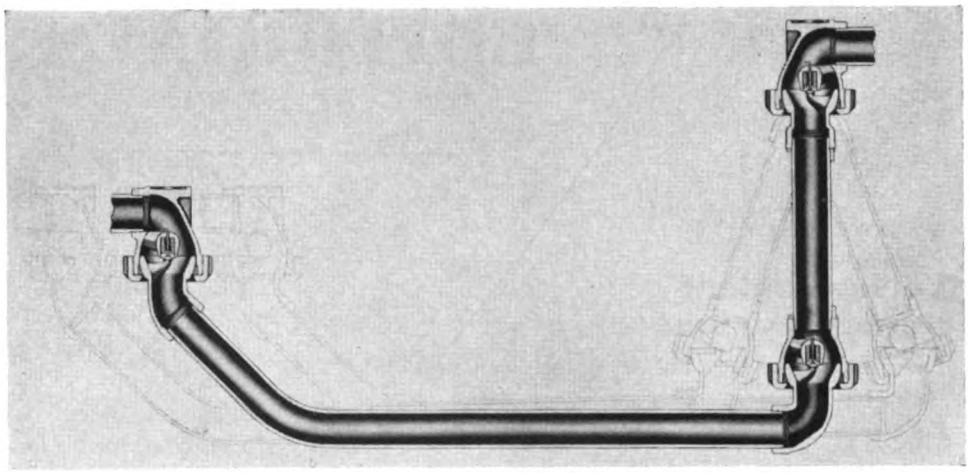
The locomotives have Elesco feed water heaters, C. F. pumps, Type E superheaters, American multiple front-end throttles and Tangential dryers. Hancock Type W nonlifting injectors are placed on the right side. Other special equipment includes constant-resistance engine and trailer trucks furnished by the General Steel Castings Corporation, Franklin unit safety bar and Type E-1 radial buffer.

The main driving boxes are equipped with the floating bushing bearings developed by the Canadian National while all other driving boxes have the standard crown bearings. The front drivers are fitted with the Alco lateral-motion device. The locomotives have Westinghouse cross-compound air compressors and ET brake equipment.

Barco Joints Improved

An improved design of metallic connection for air, oil, water and steam lines between locomotives and tenders has been announced recently by the Barco Manufacturing Company, Chicago. The new connections, known as the Type-3VX, include Type-X streamline joints, are interchangeable with the standard Barco 3V connections. If desired, therefore, the standard Barco connections now used on most of the railroads throughout the United States and Canada may be removed and the new 3VX connections applied without any alterations in the piping on the locomotive or tender and without any alteration in the brackets supporting these connections.

Some of the advantages of the new type connections for use between locomotive and tender are as follows: Only one gasket per joint is used, thereby cutting the gasket consumption by 50 per cent; the contour of the



New Barco Type-3VX locomotive-tender connection with improved streamline joints giving one-third greater flexibility

gasket has been changed somewhat to reduce the friction between the ball and the gasket and still further increase the life of the gasket as well as the life of the ball; all of the balls or metal wearing parts are hardened alloy steel forgings; heavy square threads are used to attach the nut to the casing instead of the old style V-threads, thus giving longer life to the threads.

The Barco 3VX joints provide 33⅓ per cent more movement with the same length of piping between the joints. No manual adjustment is required, and there is no possibility of tightening the nut so much as to cause binding of the ball between the two gaskets. The connections are hung vertically giving a free pendulum action. The stainless-steel springs, which are carred in a streamlined cavity in the casing, keep the spring seat on the exact center of the ball, so that the spring pressure keeping the ball and gasket in contact does not vary and is the same in all positions as the balls flex.

These joints and connections are said to have been tested on air and steam lines since August, 1937, with satisfactory results and are now being applied between locomotive and tender to the 10 new locomotives being built by the Chicago, Burlington & Quincy at West Burlington, Ia., and between engine and tender and the articulated unit of the 20 Mallet locomotives being built by the American Locomotive Company for the Delaware & Hudson.

Truck-Spring Snubbers

(*Continued from page 179*)

On the other hand, you will note how the harmonic action of the all-coil group built up over-solid blows amounting to the maximum that the instrument could record. These maximum blows represented forces 39,540 lb. over the solid spring-group capacity. Note the number of additional blows that registered forces from 10,000 lb. to 30,000 lb. over the solid capacity of the group.

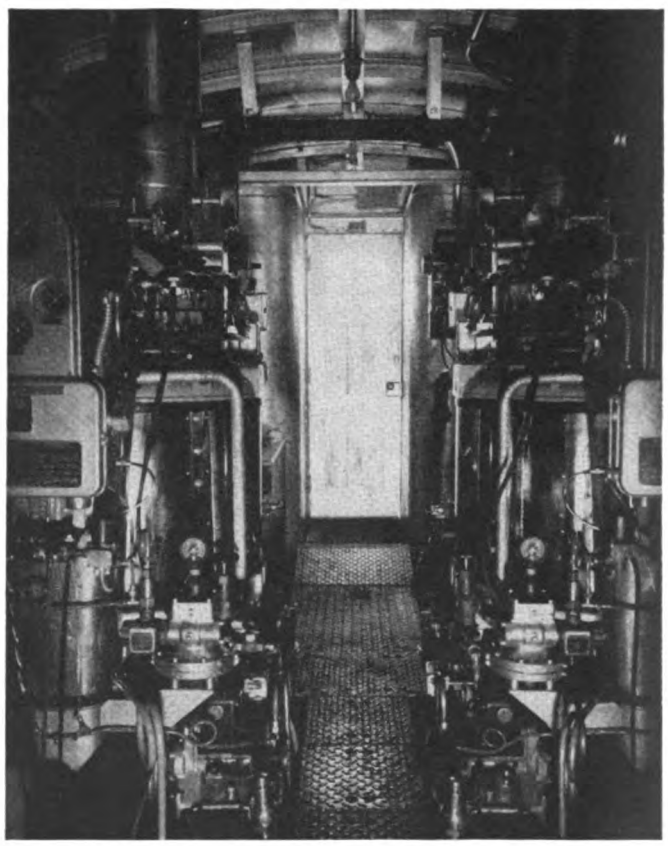
Any car maintenance items that are caused by springs going solid or by the jittery bouncing around of empty carbodies on spring groups that are too stiff will unquestionably be greatly reduced, if not entirely eliminated, by the use of truck-spring snubbers and, when you stop to consider how many car maintenance items can be effected, you will more completely realize the necessity for the use of truck-spring snubbers from a maintenance standpoint.

Illinois Central Builds Heater Cars

(*Continued from page 186*)

inating all water pockets and furnishing complete gravity draining.

The entire system is operated automatically with electrical devices, including the electric eye, which in 90 seconds will shut off operation should there be a fire failure; a high temperature switch which shuts the boiler down if the steam becomes superheated, and a stack switch which shuts the boiler down should there be excessive heat exhausting through the stacks. So, in case any portion of the system should fail of proper operation, it is automatically shut off and a gong is sounded, warning the attendant.



Interior of the heater car showing the two Clarkson steam generators

EDITORIALS

Technological Unemployment

There is no question but what technological improvements have made possible the more rapid opening up and development of the vast resources of this country. This has resulted in an unusually high standard of living for the American people, including even those in the lower income brackets. It is true that much still remains to be desired for those in the less fortunate groupings, but even as it is, their lot is far better than that of people similarly placed on other continents.

Because of the intense and long-continued depression that has extended over the past decade, much criticism has been directed against technological development, the charge frequently being made that it was largely responsible for the unemployment situation. As a result, a great deal of thought and study, much of it rather crude and spasmodic, but some of it on a scientific basis, has been given in the attempt to find how conditions might be so controlled as to minimize or largely do away with technological unemployment. Incidentally, for a time at least, engineers and scientists were under the cloud and were subjected to the harshest sort of criticism. As more sane thinking prevailed, however, they were absolved of much of the blame that had been attributed to them. So far as technological unemployment is concerned, about the worst that could be said is that the development of science and engineering has far outstripped the advance of the social sciences.

Government, in the guise of the Temporary National Economic Committee of Congress, has taken a hand in the matter, and Senator O'Mahoney's committee, ordinarily referred to as the Monopoly Committee, has been holding all sorts of hearings—from highly specialized industry investigations to the broad question of patents. It is also the sponsor of a considerable number of individual monographs on all sorts of economic questions; these are now in course of preparation. How much good will result from a political investigation of this sort remains to be seen. Incidentally, it is placing an immense amount of material of all sorts on record and it has undoubtedly challenged a considerable amount of hard thinking in some quarters.

The Brookings Institution of Washington, with funds granted by the Maurice and Laura Falk Foundation of Pittsburgh, has been making a more serious, scientific study of the problem of the distribution of wealth and income in relation to economic progress. The sixth of a series of books or reports, entitled, "Productivity, Wages and National Income," by Spurgeon Bell, has just been published. In its researches into the question of the extent to which labor, capital and the public have profited from increases in productivity, it finds that the gains to labor have proved to be chiefly in the form of greater leisure. On the other hand, the earnings on capital investment have declined. The gains accruing to the consumers in the terms of real goods and services, have been considerable. In other words, the consumers have gotten more goods for their money.

The last part of the report is concerned with the question: "Would the passing of the savings from increasing productivity to consumers generate an expansion of purchasing power?" The price of the products would be decreased making them more widely available. Since the wage and salary groups and those who contribute capital form so large a part of the consuming population, they would naturally automatically profit from the price reductions and would be able to buy a larger amount of the manufactured products. Moreover, both labor and capital would benefit from the expansion of aggregate production and aggregate employment. While the passing on of the benefits of increased productivity through the medium of price reduction would not prevent unemployment, it would undoubtedly greatly decrease it and would tend to stabilize employment.

Such studies as this are greatly to be commended. It is only by assembling all the facts and drawing logical conclusions from them that the representatives of labor and capital can intelligently get together and cooperate in such a way as to foster their mutual interests. Incidentally, this is bound at the same time to benefit the general public.

Brake Instructions For Division Officers

For the past eleven years the Kansas State Board for Vocational Education has conducted air-brake classes for railroad men as a part of its regular program. During this time 15,000 men have been enrolled in classes which have been held at twenty-five railroad division points within the state. The work has been conducted by two conference leaders. Chalk-talk lectures are the teaching medium. For the past five years the season's work has culminated in an annual conference of several days' duration, held at some central point, with an intensive educational program of morning, afternoon and evening sessions.

During February of the present year a unique feature was added to this program. This was an air-brake con-

ference for superintendents, assistant superintendents and train masters, in the arrangements for which the Wichita Board of Education cooperated with the State Board for Vocational Education. Fourteen superintendents, assistant superintendents and train masters from five railways, coming from points in five states, attended morning, afternoon and evening sessions for two days, in which conferences were alternated with lectures of an educational character dealing primarily with brake fundamentals and problems of the operating officer in matters of train-handling practice, discipline, federal inspection, etc.

The officers and supervisors of the mechanical department have long been accustomed to consider the air brake and all its problems as belonging quite exclusively to them. In matters of maintenance and details of the functioning of the various triple and control valves the monopoly of the mechanical department is not likely to be challenged. There is every reason, however, why division officers having to do directly with train movement should understand the functions, the limitations and even the most common sources of failures of the air brake equipment in their trains. Those men who have come up directly from the train service, no doubt, have a good background knowledge and even skill in train handling. Not all division officers have this background, however, and even those who do have it can benefit from an occasional period of intensive instruction on the newer types of brakes which are now coming into service. The conference sessions at which problems of the supervisors can be propounded and discussed should be of even greater value to men in such positions than the strictly instructional part of the program. Two days in a conference of this kind could be well spent by division officers and supervisors every year.

Flame-Hardened Stoker Screws

The abrasive action on the blades, or flights, of conveyor screws used in locomotive stokers is exceptionally severe and many railroads exercise notable ingenuity in developing ways and means of rebuilding the worn flights to their original size and hence reclaiming stoker screws for further service. The only caution which needs to be observed in this connection is to make sure that, considering all the various items of labor and material costs of reclamation, the time the stoker is kept out of service and the probable further service life of the reclaimed stoker screw, it would not be cheaper to buy a new one.

Based on some observations in the industrial field, the thought has been advanced that possibly the effective service life of locomotive stoker conveyor screws could be increased, and the time when they need extensive repairs substantially lengthened by flame-hardening the flights. According to a recently published article, the only equipment necessary for this job is a lathe or other convenient means for turning the conveyor screws on centers, a standard welding blowpipe and a small water supply line for quenching purposes. The progressive method of flame-hardening is employed, the operator handling both the blowpipe and the quenching water hose, while an assistant turns the stoker conveyor screw by hand. The blowpipe tip is held from ½ in. to ¾ in. away from the outer edge of the flight and the quenching water supply pipe follows the blowpipe as closely as possible without actually interfering with the flame. Thus heating and quenching are carried on simultaneously, proceeding slowly along the outer edge of the flights from one end of the screw to the other. The heating of the steel just above the critical temperature and the subsequent cooling produces a hardening effect approximately ⅛ in. deep over the entire outside diameter. A metal trough placed below the conveyor screw serves to catch and drain off the water.

Possibly this method of securing increased service life from stoker conveyor screws is now being used on one or more railroads, but if so, *Railway Mechanical Engineer* has not heard of it and would appreciate receiving information describing in some detail how the work is carried out. Presumably, the extent of the hardened area can be governed by controlling the amount of heat supplied by the blowpipe and the volume of quenching water applied. It is logical to ask how wide a hardened area would be desirable and also how much the hardness can be safely raised without sacrificing some degree of toughness and necessary strength. Another query which might be worth investigating is regarding the possibility of mounting both the blowpipe and the quenching water supply on a special carriage with feed adjusted to the pitch of the conveyor screw.

One general observation may be made in connection with this and other similar jobs and that is that if they are being handled with satisfactory results in general industry, there is more than an even chance that they may be profitably adapted, to some degree at least to railway practice. In the ever-present urge for economy in railway shop operation, aggressive mechanical officers will not overlook any opportunity to find out what the "other fellow" is doing and which of his methods can be applied to advantage in reducing the cost of car and locomotive maintenance work.

Why Should Diesel Repair Costs Be High?

Within recent years, during the time that Diesel-electric locomotives really have been installed in road passenger service, many persons have expressed skepticism concerning the chances for the ultimate success of that form of power. In this respect, the Diesel-electric

shares a situation which has confronted practically every major development that has been introduced in the railroad field. It is but natural to question that which is new and radical. Fortunately, the development of this form of motive power was predicated on a real need and its future will depend almost entirely upon how well it may be able to solve a problem that is economic rather than engineering in character.

A number of reasons have been advanced as to why the Diesel-electric might cost more or less than steam as a means of moving trains and, over a period of 10 years, the factors of wages, fuel, maintenance, lubrication, supplies and enginehouse expense have been discussed pro and con until we are actually approaching the time when experience may answer the questions. It is not the purpose here to become involved in any consideration of the items that make up the cost of operation of either Diesel or steam power other than the single item—cost of maintenance.

The cost of maintenance of any type of motive power includes the normal every day repairs made as a result of inspections before and after each trip, as well as the major repairs that are made when a locomotive has to be given a general overhauling. Maintenance cost also includes the expense of making inspections. In the case of the steam locomotive it is the traditional practice to shop it at intervals usually governed by mileage or length of service and make such general repairs, in many cases actually a rebuilding job, as will condition the unit for another term of road or yard service. In the case of the Diesel-electric the maintenance practice must be considered with due respect to the character of service in which it is used. Switching power, which has now been in service on some roads for 15 years, is being maintained in much the same manner as steam power; that is, it is being given general repairs at periods varying from one to two years. Road locomotives will undoubtedly follow much the same general plan when a sufficient number of them have been in service long enough to determine the most economical methods to be used. There is an essential difference in the repair practices relating to steam and Diesel in that one is in the nature of a rebuilding job, wherein major parts are manufactured in railroad shops for application to the unit undergoing repairs, and the other—the Diesel—is practically a parts-replacement job involving the renewal of standardized parts secured, for the most part, from the manufacturer of the original equipment.

Before there can be any consideration of maintenance costs the basis of determining costs and the manner of expressing costs must be established. It might be well to point out at this stage of the discussion that Diesel-locomotive operating costs are being kept by most roads on the basis of individual units—a basis of cost keeping that has rarely been considered practical with respect to steam power. There can be a vast difference between the maximum and minimum costs of the individual units in a group of, say, 50 locomotives and the average cost of the entire group. Therefore, in any consideration of comparative costs this factor should should be recognized.

It has been customary to use the per-mile figure as a measure of steam-locomotive costs. Practically all roads using Diesel switching power are recording operating costs of that type of power on a per-hour basis whereas such costs relating to steam power have been, until recently at least, on a per-mile basis, using an arbitrary six-miles-an-hour figure as a means of determining the mileage. Now we are beginning to see cost figures of Diesel road locomotives indicated on the mileage basis. In that respect Diesel costs may be directly compared to steam in spite of the fact that the comparison, once made, means very little unless it is related to the many conditions surrounding the character of service for which the motive power units are used.

Many railroad men have expressed the opinion that the maintenance costs of Diesel locomotives would probably be much higher than steam, so the question is asked, "Why should Diesel repair costs be high?" The plain fact of the matter is that when an analysis is made of the various factors involved in the maintenance of Diesel locomotives, as compared with steam or straight electric power, there is no good reason to believe that Diesel costs should be as high as either steam or straight electric.

In order to explore this suggestion a little farther it might be worth while to use some figures. For road power only a good figure for steam locomotive repair costs would be from 15 to 25 cents per mile. This includes both passenger and freight power. If the cost of repairing passenger power only could be segregated and related to the greater utilization and mileage in that class of service it is possible that a much lower average per-mile figure would result. On the other hand the costs of repairs for individual units, in exceptionally high-speed service might be very much higher. For electric locomotives, four roads handling a large volume of both freight and passenger traffic report locomotive repair costs varying from 11 to 25 cents a mile, with an average, for one recent year of 15 cents a mile. Diesel-electric road locomotive repair costs recently reported by one road are 11 cents a mile. It is admitted that the very meagre amount of Diesel cost data available justifies hesitation in making comparisons.

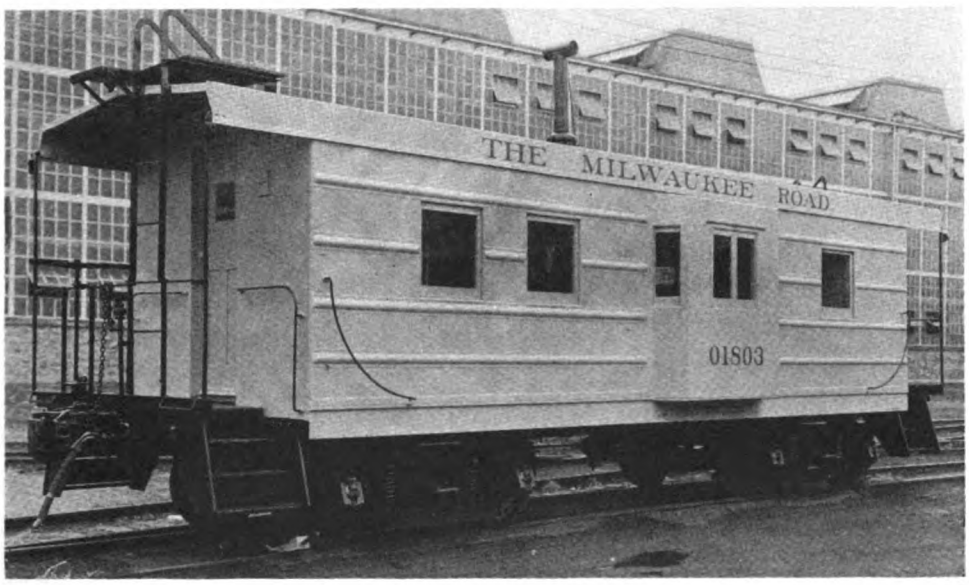
One thing is certain. In order to determine beyond question what type of motive power is best suited to a given set of operating conditions the railroads are now faced with the necessity of keeping costs in greater detail than has heretofore been considered necessary. The answer to the specific question raised in this discussion can not be arrived at on the basis of the data available at present. Experience so far does seem to indicate, however, that Diesel repair costs probably will not be as high as many railroad men once thought they would.

New Cabooses Built at Milwaukee Shops

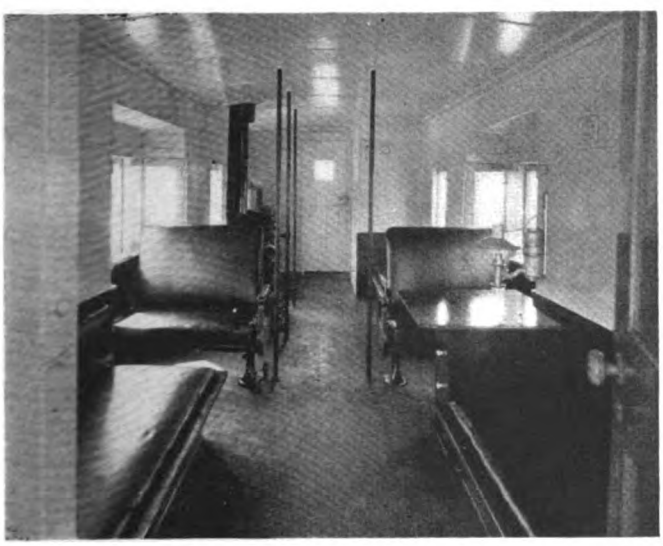
During 1939 the Chicago, Milwaukee, St. Paul & Pacific built at its Milwaukee, Wis., shops, 75 new cabooses which are notable for their attractive appearance, easy-riding qualities, neat and bright interiors and the provision of all facilities essential to the comfort and convenience of train crews and hence contributing to the easier and more satisfactory performance of their work. From the point of view of external appearance, it cannot be questioned that these cars are a source of favorable publicity for the Milwaukee road.

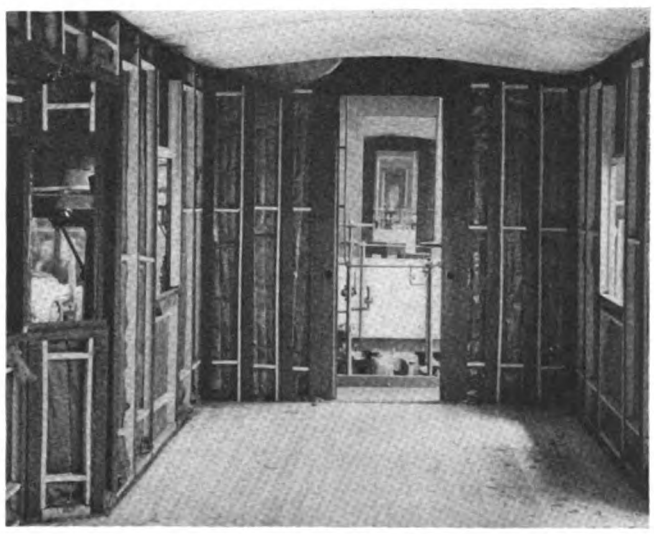
In accordance with what has come to be standard Milwaukee practice, the new cabooses have side-observation bay windows which enable trainmen, while seated at normal floor level, to obtain an excellent view along the full length of the train, especially when rounding a curve on the side from which observations are being made. The conventional type of cupola, now in general use on older cabooses on the Milwaukee and other roads has been shown by experience to have a number of disadvantages which the new type of bay window is designed to overcome. In the first place, with a high box or automobile car coupled next to the caboose, the trainmen's vision of what is going on up ahead in the train is almost completely blocked and frequent use must be made of the side windows in the cupola to make sure that no unsafe conditions are developing on the train. The old cupolas are also difficult to maintain rigid and free from air leaks, and consequently they are sometimes hard to heat to a comfortable temperature. While the physical effort and time involved in climbing up into and down out of a cupola would not ordinarily be significant, under certain conditions, it might be of vital importance. All of these more or less objectionable features of the caboose cupola are overcome by the side-observation bay windows now being installed on new Milwaukee cabooses.

Each of the new cabooses built at Milwaukee shops in the 1939 program is 35 ft. 3¼ in. long over the striking castings, and has a light weight of 38,800 lb. The inside width is 8 ft., which is increased to 10 ft. at the bay section, each bay, therefore, projecting 12 in. beyond the normal car side. The maximum outside width



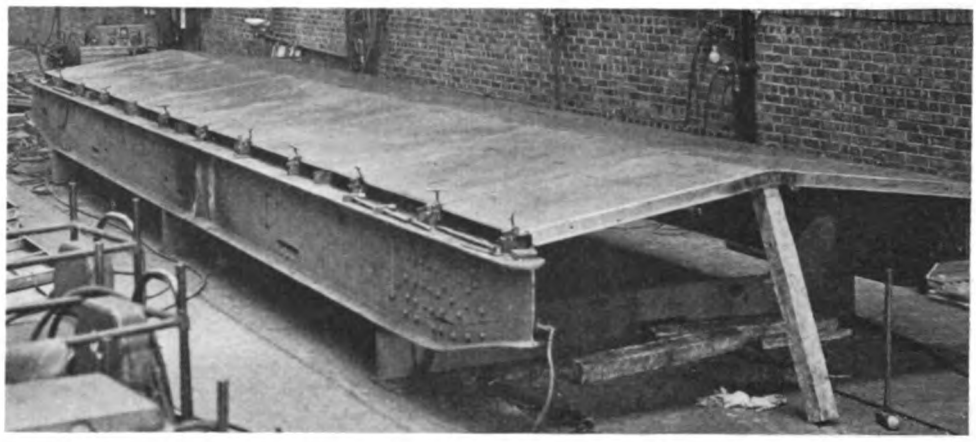
The completed caboose ready for service

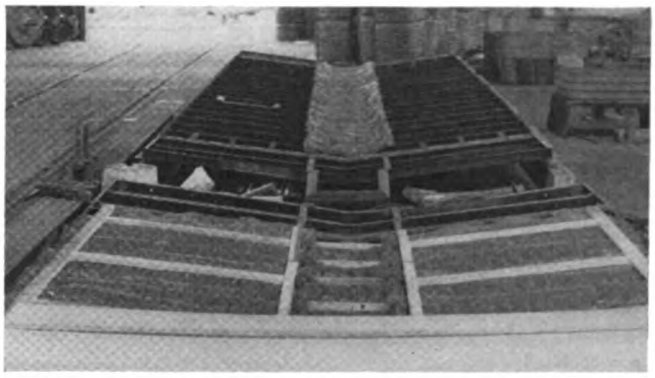




Left: Inside of a finished caboose—Right: Interior side insulation and top floor under which cork insulation is applied

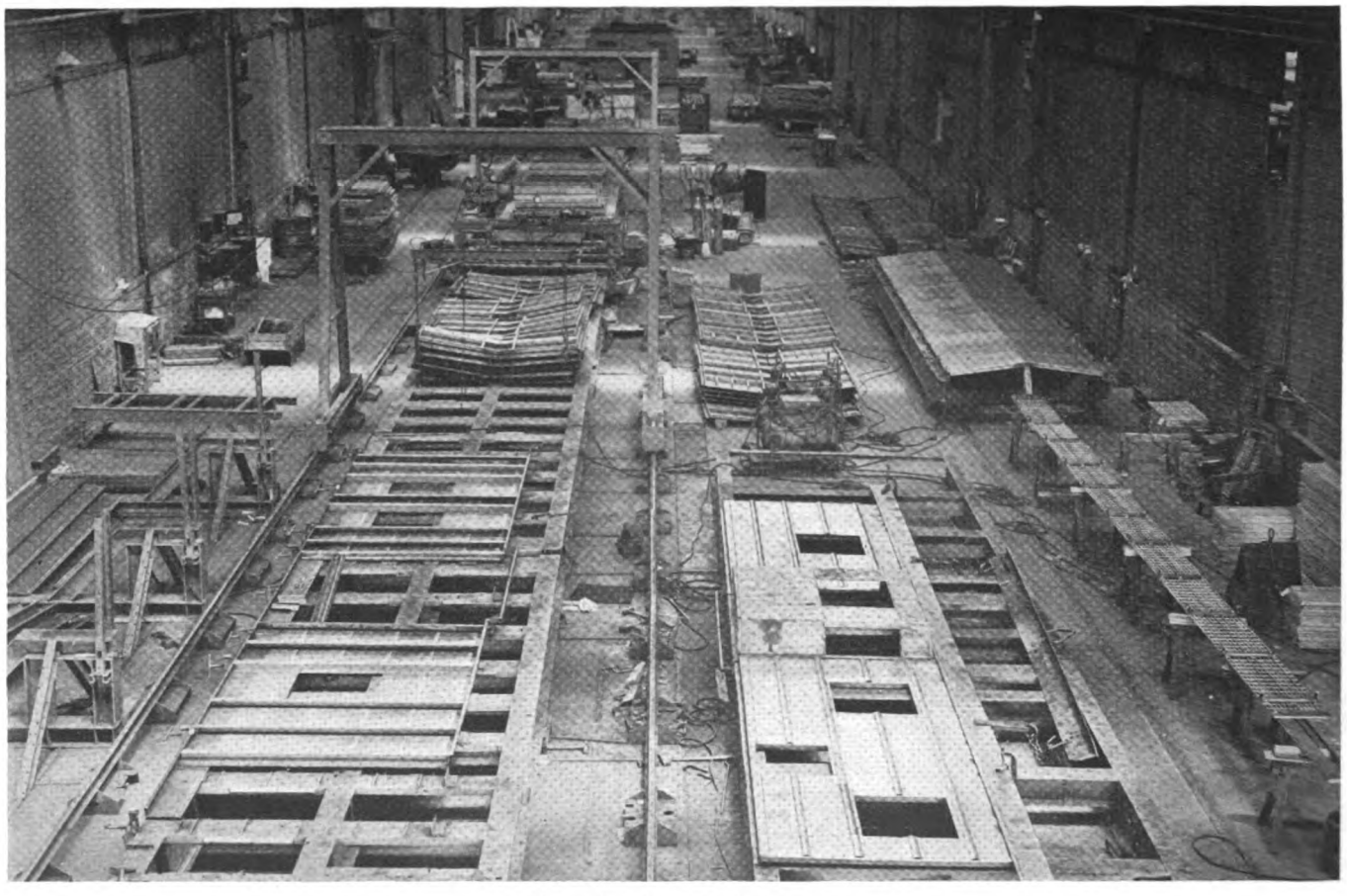
Right: The roof welding jig —Below: Placing the insulation and ceiling panels





Principal Dimensions of 75 New Cabooses Built at Milwaukee Shops in 1939

Length over striking casting, ft.-in.	35- 3¼
Length over running boards, ft.-in.	36- 0
Inside length, ft.-in.	28- 0
Inside width, ft.-in.	8- 0
Inside width—bay, ft.-in.	10- ⅛
Height—side sill to rail, ft.-in.	2-10$^{13}/_{16}$
Truck centers, ft.-in.	19- 1½
Width over side sills, ft.-in.	8- 6½
Width over side frame, ft.-in.	8- 7½
Width over side frame—bay, ft.-in.	10- 8
Width over eaves, ft.-in.	8- 7$^{13}/_{16}$
Height—top of rail to body center plate, ft.-in.	2- 1¾
Height—top of rail to floor, ft.-in.	3- 8⅝
Height—top of rail to eaves, ft.-in.	10-11 $^{5}/_{32}$
Height—top of rail to running board, ft.-in.	11- 8¾
Height—top of rail to top of ladder stile, ft.-in.	12-10¼
Height—top of rail to top of bay—outside, ft.-in.	9- 9$^{17}/_{32}$

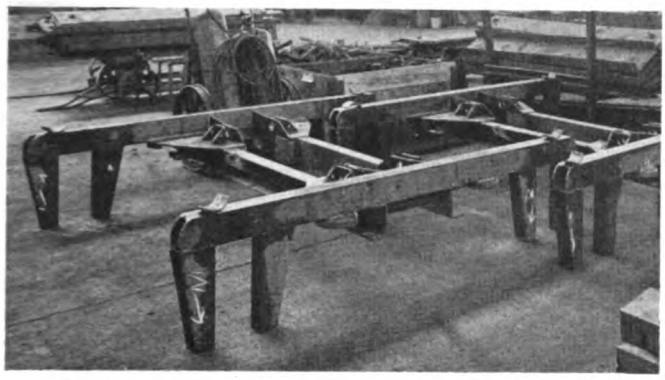


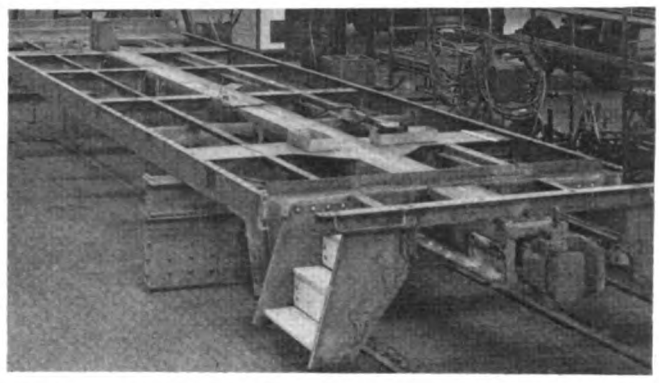
Side, roof, and running-board jigs

is 10 ft. 8 in. The inside height at the car sides is 6 ft. 11 in. The four-wheel trucks, supported on 4½-in. by 8-in. journals, are equipped with drop equalizers and a combination coil and elliptic spring arrangement designed to assure easy riding.

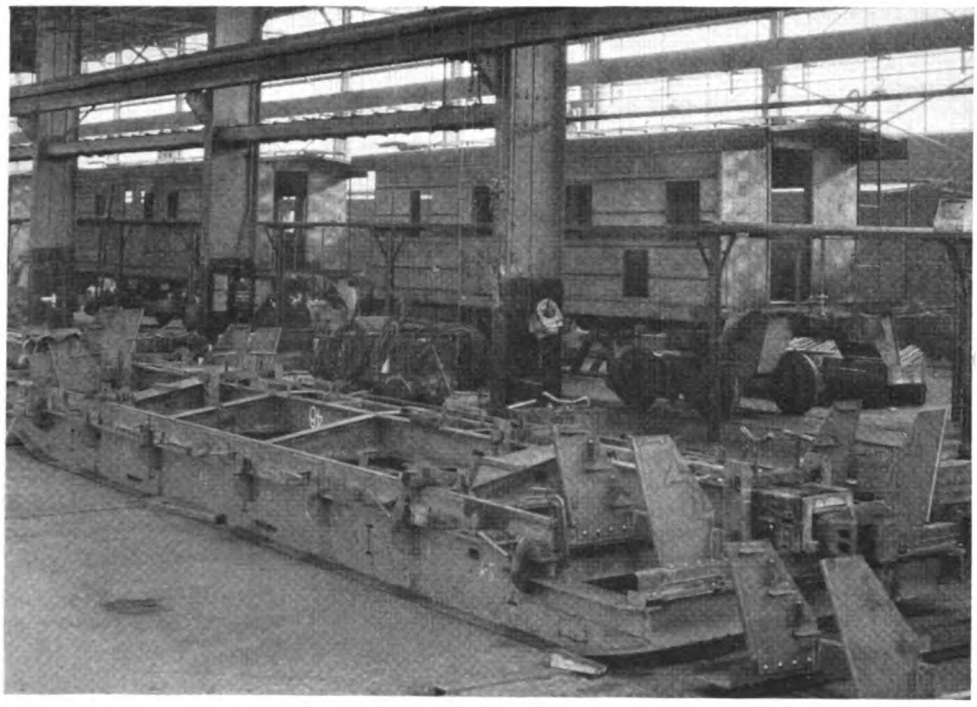
The car is of all-welded construction, the center sills being A. A. R. section, with couplers, yokes, draft gears and air brakes meeting the builders' standards for caboose equipment. The car is well insulated and equipped with necessary lockers, stove, lights, two reversible observation seats, three seats with 2-ft. by 6-ft. cushions, toilet and wash facilities. The inside finish of the car is plywood. In one corner of the car between the stove and the end of the car is the coal bin, a drain board, sink, cooler and ice box. On the opposite side at this end is placed a roomy locker with two compartments, the upper being used for oil cans and lanterns and the lower for jacks and brasses. The air gage is located well up on the wall of this locker where it can be readily seen and the emergency valve is conveniently located adjacent to the gage.

Referring to the illustrations, the general method of constructing these all-welded steel cabooses at Milwaukee shops will be apparent. In the large illustration on page 194 the complete side welding jig is shown in the foreground, roof jig in the rear and running-board jig at the right. The roof welding jig is shown at the top of the page, the general method of assembling the roof section sheets preparatory to welding, being clearly indicated. In the other view the roof is seen in the inverted position ready for the application of roof insulation and plywood ceiling panels. The underframe welding jig, shown on the next page, is used in assembling the center, side and end sills, bolsters and crossbearers in the up-side-down position to facilitate welding. The underframe is then placed right side up to complete welding, and the step treads are applied. The truck frames are completely fabricated by welding.





Above left: Truck frames are fabricated by welding—Above right: Where underframe welding is completed—Below: Underframe parts are welded in a special jig



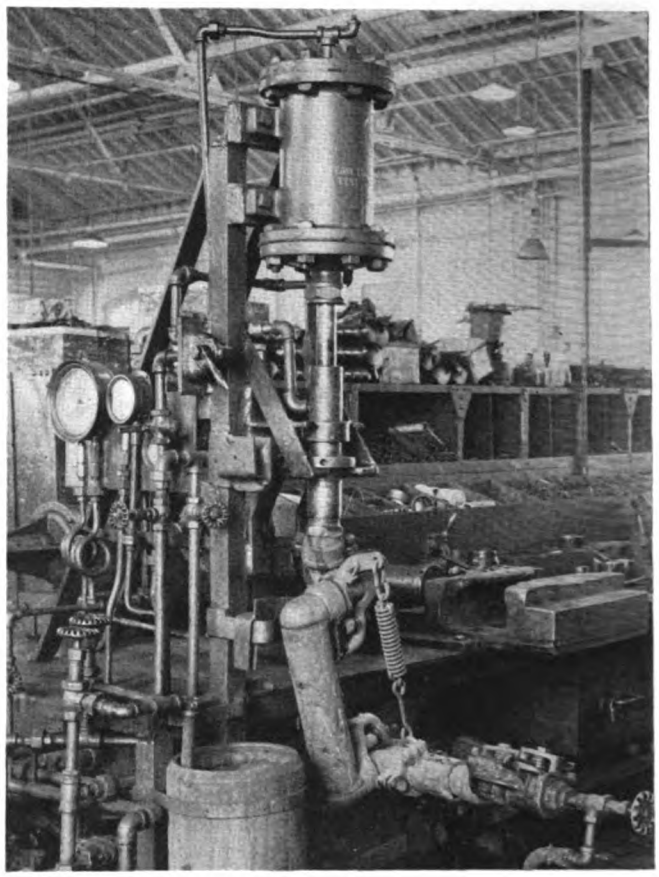
TRAVEL ON "400" INCREASES.—Passenger travel on the "400" operated by the Chicago & North Western between Chicago and the Twin Cities, showed an increase of 53 per cent for March, 1940, as compared with the same month in 1939 before the present streamline equipment was placed in service. From October 1, 1939, through February, 1940, total revenue increased 51.9 per cent over the corresponding period in 1938-39, the totals being $458,653 and $301,901, respectively.

Test Rack for Steam-Heat Connectors

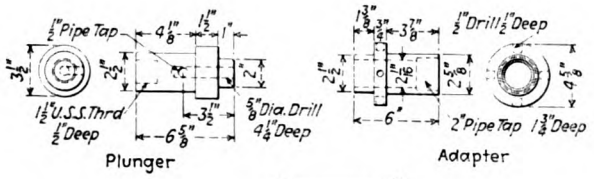
A test rack developed by the air-brake department at the West Albany car shops of the New York Central to expedite the testing of Barco and Vapor steam-heat connectors is shown in the accompanying photograph and schematic diagram. The arrangement permits the connectors to be quickly tested under steam pressure and then rapidly cooled by water to a temperature at which they can be handled.

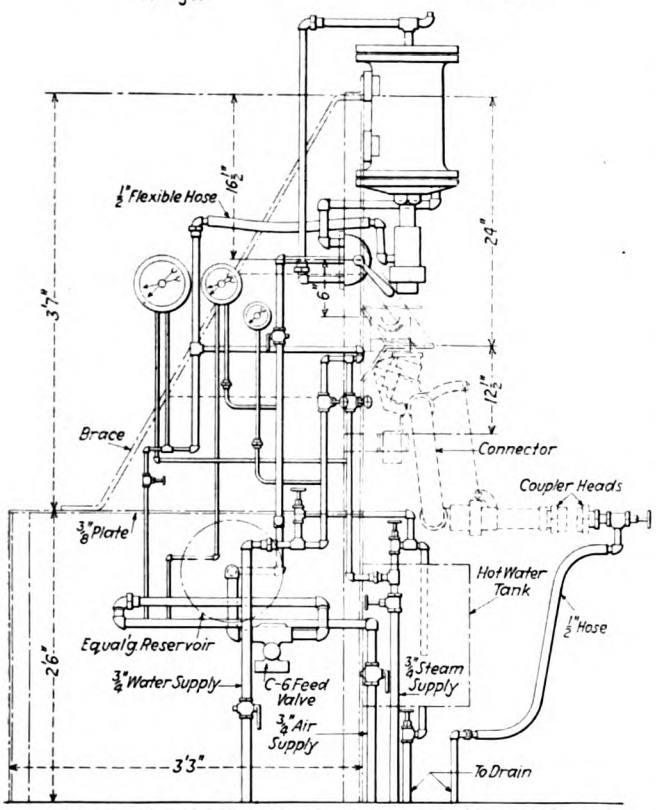
The test equipment is supported by a table and frame fabricated of steel angles and plates by electric welding. A 5-in. double-acting air cylinder with a steel plunger attached to its piston rod is bolted to the top of the frame in a vertical position. The plunger has two functions. It makes a steamtight joint with the steam-heat connector under test, and it is the means through which steam and water enter the connector. The details of the plunger are shown in the drawing. The plunger has a 5/8-in. hole bored a little more than half way through its center axis. A hole is drilled from the side of the plunger to its center and is tapped to receive a pipe connection through which the steam and water is supplied. Because of the movement of the plunger, a 1/2-in. flexible metallic hose is introduced between the pipe connection on the plunger and the supply pipe.

The air for operating the air cylinder comes from the shop air line through a feed valve which reduces the pressure from 140 to 60 lb. per sq. in. After passing through the feed valve, the air is stored in a 10-in. by 14 1/2-in. equalizing reservoir in order that a sufficient volume of air at the reduced pressure will be available when required. A locomotive sander valve is employed as an operating valve to control the movement of the air piston. The air, steam, and water pressures are indicated by the gages mounted at the side of the unit.



Testing a Vapor steam-heat connector in the rack





Schematic diagram of a test rack for steam-heat connectors

Figure 1 shows the rack in which the connectors are tested. The bracket directly under the air cylinder supports the connector while being tested. The Barco connector rests directly on this bracket, but it is necessary to screw an adapter on to the Vapor connector which rests on the bracket when this type of connector is tested. The details of the adapter are given in the diagram. The Vapor connectors are also supported by a lower bracket as can be seen in both illustrations.

The tank at the bottom contains hot water in which ferrules are heated in order that the gaskets may be readily removed. After heating, they are placed in a bracket in which they are held while the gasket is removed. This bracket may be seen in the photograph directly beside the top connector support.

In operation, the end of the steam-heat connector or the adapter is placed on the support below the air cylinder, and the piston is lowered until the plunger makes a steam-tight joint with the connector, and is held in this position by the control valve. A coupler head is attached to the other end of the connector. This coupler head is fitted with a valve and hose through which the steam and water can be controlled and discharged. The water valve to the intake line is shut off and the steam valve is opened to admit steam through the flexible hose and the plunger to the connector. The connector is tested under steam pressure, after which the steam supply valve is closed, and the steam is discharged by opening the valve in the coupler head. Then, water is admitted to the connector and allowed to flow through until the temperature is reduced to a point at which the connector can be conveniently handled.

Sash Cleaning and Glazing Methods

The Point St. Charles car shops, Montreal, Que., of the Canadian National utilize two labor-saving devices for the removal of old putty from window sash being reconditioned and to reputty the sash after the application of the glass. Fig. 1 shows a bench drill equipped with a special cutting tool for cleaning old putty from sash and Fig. 2 illustrates an air-operated sash-glazing unit.

The special tool for cleaning the old putty from the sash has four cutting edges faced with ⅛-in. Carboloy as shown in Fig. 3. This cutter is assembled on a ½-in. rod with a bushing of $^{31}/_{32}$ in. diameter inserted between the cutter and the holding nut. The function of the bushing is to act as a guide for the cutter and prevent the operator from cutting into the sash. It insures the cleaning only of the width of the sash edge on which the glass is supported. It is, of course, necessary to remove the old putty from a small area in the corners by hand as the circular cutter can not reach these points.

A wood frame has been erected around the bench drill as a support for the sash and over which the sash may slide as the old putty is removed. The special cutting tool, assembled on the rod, is held in the drill by a chuck.

The sash-glazing device for applying new putty which is shown in Fig. 2 consists essentially of a cylinder filled

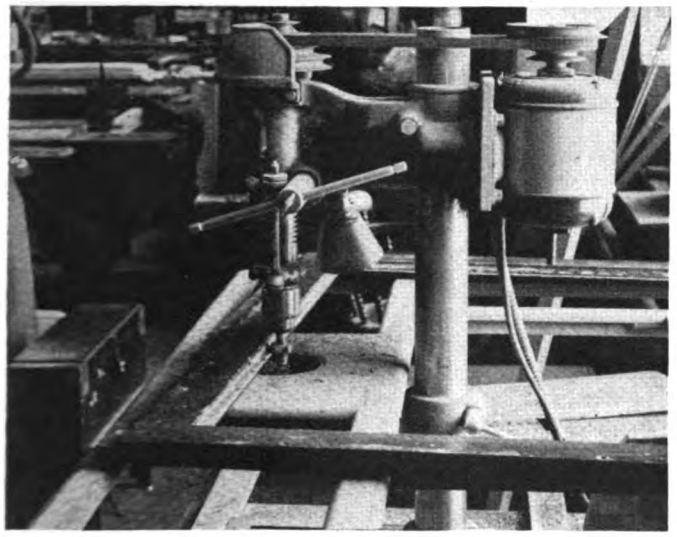


Fig. 1—The vertical bench drill equipped with a special tool for cleaning old putty from the sash

with putty which is forced through a flexible hose and nozzle by air pressure acting on a piston. The cylinder has 5⅞ in. inside diameter, a straight circular section of 15⅞ in. length at the top, and a conical section, 5½ in. in length, at the bottom ending in the outlet to the flexible hose. A water jacket, open at the top, surrounds the inside putty cylinder. The jacket cylinder is made of $^{1}/_{16}$-in. steel with an inside diameter of 11 in. and is welded to the inside cylinder at the bottom of the conical section. In the water space are coils of ¼-in. pipe encircling the inside cylinder through which steam passes to heat the water. The hot water heats the putty and keeps it in a state plastic enough to be forced through the cylinder and hose.

The ⅝-in. piston rod extends through a packing gland

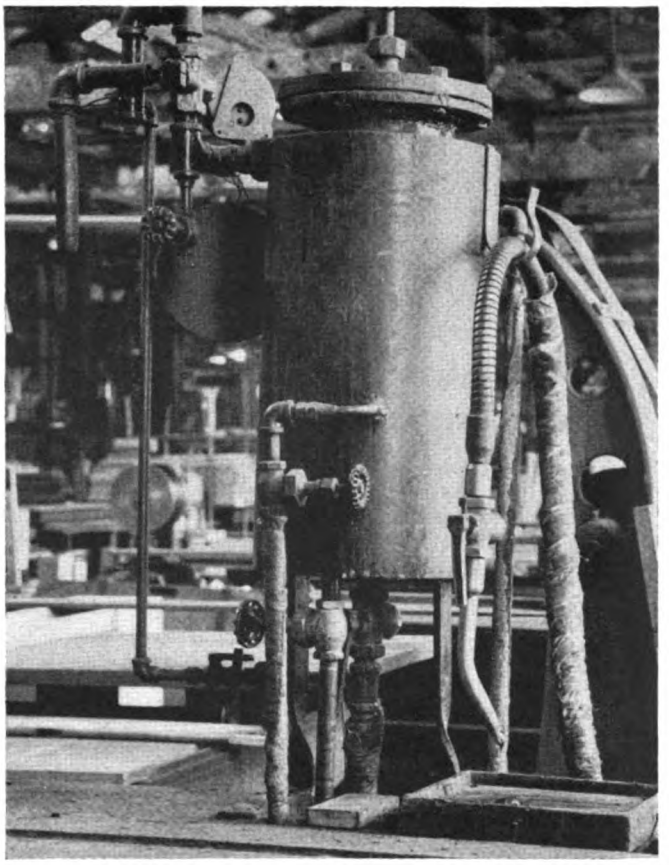


Fig. 2—Sash-glazing device for applying the putty

in the cylinder head and at its upper end is a weight which keeps the piston head down against the putty at all times. The weight is located so as to act as a stop when it reaches the top of the stuffing box and thus limit the piston travel. The flexible bronze hose is 7 ft. long and has a ¾-in. inside diameter.

The air supply is through a ¾-in. line and passes through a main control valve before entering the cylinder 1¾-in. from the top. The air pressure is indicated by a gage mounted on a bracket near the top of the unit. The air in the cylinder may be released through a ½-in.

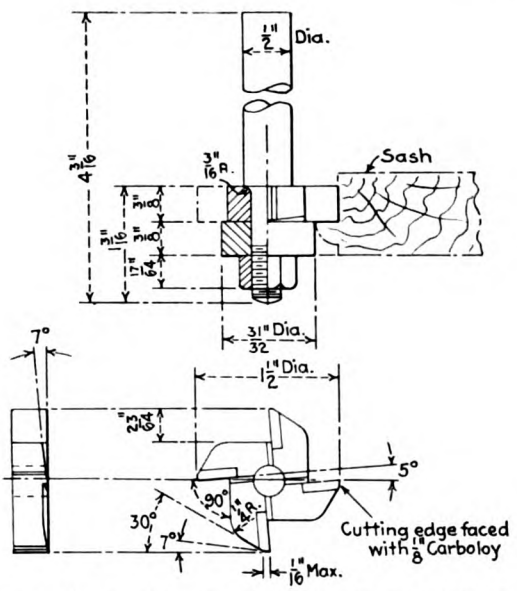


Fig. 3—The special cutter used with the vertical bench drill for cleaning putty from the sash

pipe tapped into the air intake line. A ¾-in. cock is at the outlet of the putty cylinder and between this cock and the flexible hose coupling is a pipe tee through which air is supplied to clean out the hose and prevent its stoppage by the setting of putty remaining in it for long intervals of time.

The control valve at the nozzle can be adjusted to regulate the rate of flow of the putty. The sash glazing device not only permits the putty to be applied quickly but makes possible the distribution of the putty in the exact amount required for any sash.

Air Brake Questions and Answers

D-22-A Passenger Control Valve (Continued)

570—*Q.—What maintenance improvement is obtained by this design?* A.—While serving as a lock, the spring also acts to maintain a positive contact between locking surfaces, thus avoiding loose movements and resultant wear.

571—*Q.—How are the pipe connections made to all operating devices of this equipment?* A.—By means of re-inforced pipe fittings of the flanged-union type.

572—*Q.—For what purpose are these fittings used?* A.—To produce iron, steel or copper pipe joints which can be maintained air tight and at the same time avoid failures in road service due to breakage of pipe or fittings. The fitting is designed to clamp the pipe back of the threaded end of the iron pipe so as to relieve the threads of tension stresses, and is so arranged as to permit ready removal and re-application.

573—*Q.—Why is it important that these fittings be correctly installed?* A.—If not, the protection against pipe failures at the point of the exposed threads may be lost.

574—*Q.—What is the correct method to follow when applying pipes with these fittings?* A.—After slipping the clamp nut and anchor ring over the threaded end of the pipe, the flanged fitting must be screwed on the pipe so as to make a rigid and air tight joint at the threads when the bolt holes are in line with the tapped holes in the face to which it will be bolted. The anchor ring and clamping nut must then be moved into place and the nut firmly tightened so as to close the anchor ring solidly on the pipe.

575—*Q.—What must be done to insure that the anchor ring will have full supporting bearing on the pipe?* A.—The thread must be straight, that is, cut substantially parallel with the axis of the pipe, which will automatically occur if the pipe threading tools are in good condition.

576—*Q.—How must the pipe be so formed and Fitted?* A.—So that when it is in place, the face of the flanged fitting, with the gasket removed, will contact squarely with the surface to which it will be clamped and that the bolt holes are in line to permit application of the cap screws without springing the pipe. The gasket can then be applied and the fitting clamped in place with the cap-screw bolts which should be solidly tightened.

577—*Q.—What is the proper method of installing a control valve on a car?* A.—The bracket should be installed as near the brake pipe as possible so that the branch pipe may be short; short bends in the piping should be avoided also. Care should be taken in locating the valve to have it free from obstructions which would render inspection or removal difficult. The control valve should be placed above the general level of the piping and the piping so arranged as to avoid pockets in which moisture may collect.

578—*Q.—What may happen if this point does not receive proper attention?* A.—Trouble may be experienced in cold weather from the freezing of water in the pipes or in the valve.

579—*Q.—What precautions should be taken in respect to the installation of piping used with the control-valve equipment?* A.—Before installing the control valve, all of the piping should be thoroughly hammered and blown out, in order to loosen and remove all scale or foreign matter. A suitable compound to make a tight joint should be applied on the male threaded portion only, and never in the socket. Do not use red or white lead. After the piping is complete, all joints should be thoroughly tested under pressure with soapsuds and made air-tight.

580—*Q.—When necessary to clean and lubricate the control valve, should this be done at the car?* A.—Never remove the operating parts of the control valve at the car. If one of the portions of the valve is not working properly, or needs cleaning and lubricating, take it down and replace by a portion in good condition. All cleaning and lubricating should be done at a bench, by a competent man, where the liability of damage to the internal parts is least. Any attempt to remove the moving parts of the valve while still on the car is almost sure to result in a large percentage of valves being injured by careless handling or dirt getting inside the pipes or valves.

581—*Q.—How should the service portion be cleaned and lubricated?* A.—The piston, slide valve, and graduating valve and bushings must be thoroughly cleaned so as to remove all dirt, oil, gum or grease. Benzine, gasoline or other approved cleaning fluid can be used for this purpose. The packing ring and its groove should be cleaned without removing the ring from the piston groove. This can be done by dipping the piston in the cleaning fluid and then moving the ring around the groove. This operation should be repeated until the groove and ring are thoroughly cleaned, after which the excess cleaning fluid can be blown away or dried by using an air jet. Where rings are stuck with dirt too tightly to be moved in the groove, it may be necessary to soak the ring in penetrating oil and then tap the ring lightly with a hard wood block. For this purpose, a maple or hickory wooden block about 1 in. by 1 in. by 4 in. (with square ends) should be used to tap the ring so as to drive it flush with the top edge of the groove.

582—*Q.—How should this tapping be done?* A.—This tapping should start at one side of the ring joint and progress around the piston in short steps until the ring is loosened sufficiently to be moved in the groove.

583—*Q.—If this procedure will not loosen the ring, what must be done?* A.—It is evidence that the groove must be reconditioned and a new ring fitted.

584—*Q.—How must the slide and graduating valves be lubricated?* A.—The face of the graduating valve, the upper surface of the slide valve (which is the graduating valve seat), the slide valve seat, and the upper portion of the bushing (slide valve spring bearing), must be glazed with the best grade of very fine, pure, dry, air-brake graphite applied with a paddle made of wood about 8 in. long having a small piece of chamois skin glued to the paddle end. There must be no free graphite allowed to remain on the valves or seats and they must be free from any oil or grease before the graphite is applied.

A New Atlas Journal Jack

A light and compact Atlas journal jack, recently developed by the Railroad Division of the Portable Plating & Equipment Co., Chicago, weighs complete with 25-ton hydraulic unit, only 62 lb. Changing brasses with this jack is said to be usually completed in two to four minutes—less time than is required to get most other types of equipment into position. Changing or inspecting brasses, regardless of weather conditions, therefore becomes a simple routine.

The Atlas journal-jack equipment consists of three units: (1) A strong steel arm or hook which attaches securely to the top of the car wheel, (2) an oversize cable as an integral part of the adjustment ladder and a platform or stirrup for the jack unit, (3) and the small but powerful Atlas 25-ton hydraulic jack. All three units combine to promote safe, fast and dependable brass



Atlas 25-ton hydraulic journal jack as used in inspecting and servicing a freight-car journal and changing the brass if necessary

changing and inspection. The Atlas journal jack requires no heavy cumbersome blocks or wheel hold-down plates. There can be no wheel movement, as the entire suspended weight is transferred directly to the wheel. The adjustment ladder readily adapts the equipment to journal boxes of various sizes.

As the lifting pressure on the journal box reacts directly to hold the wheel down (see illustration) it will be apparent that bearings can be safely and easily inspected or a brass immediately replaced on any track. The train crew or car inspectors do not need to carry special blocking or fittings. Ice, snow, mud, soft ground, or decayed ties offer no handicap, as the use of this jack is independent of the roadbed condition.

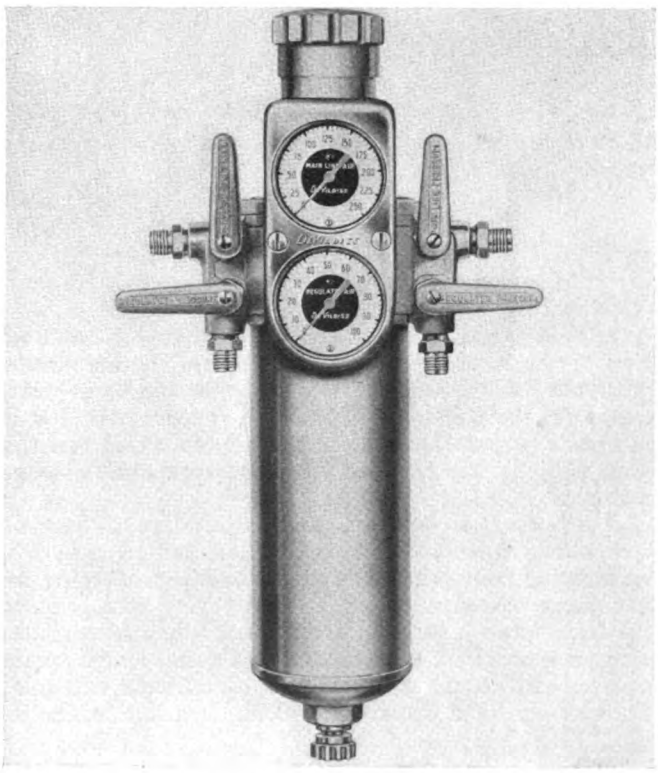
One of the most important advantages of this type of jack is that it helps keep special freight moving. It readily facilitates the servicing of a hot box, thus avoiding serious delays and frequently avoiding the necessity of cutting out cars enroute. Perishable freight is kept moving, at a great saving to the carrier and substantial benefits from improved shipper relations.

The Atlas journal jack is safe, portable, and strictly a one-man journal-bearing remover. As a separate unit, the jack is adaptable to general railroad maintenance work. It has a lifting power of 50,000 lb., light weight of 27 lb., and small size, 6½ in. high. It is convenient for changing locomotive spring hangers and tender-truck bearings, spring planks on passenger coaches and for use under the side-frame members of freight-car trucks, in this instance enabling both journal wedges and both brasses to be quickly removed in one operation.

Air Transformer for Spray-Painting Process

A new air transformer, known as the Type HLC, has been developed by the DeVilbiss Company, Toledo, Ohio. This equipment is for use in the spray-painting process to furnish the spray gun with clean, moisture-free air. It handles in excess of 50 cu. ft. of air per minute. The transformer will pass an ample supply of air for two spray guns in continuous and simultaneous operation or for three spray guns in ordinary, intermittent production use.

This equipment has a synthetic-rubber regulator diaphragm and a big regulator knob conveniently located. A large condensing chamber allows for greater air expansion and more thorough condensation of moisture. The air is cleansed effectively by an improved baffle arrangement. The new metal filter, wholly mechanical, eliminates the cotton waste pack and the necessity for its repeated removal and replacement. The enclosed pressure gages and the die-cast body complete the streamline style of the transformer. The cylinder is chromium plated and highly polished to prevent the accumulation of dirt, dust, or paint so that the exterior of the equipment may be easily kept clean.



The DeVilbiss Type HLC air transformer furnishes clean, moisture-free air to the spray gun

The Reinforcement of Defective Boiler Shells*

By E. H. Heidel

One of the problems confronting the boiler foreman is to decide what type of repairs to make to the boiler shells of the older and smaller locomotives still in use in considerable numbers on branch lines and secondary divisions. These boilers are from 25 to 30 years old, carry in the neighborhood of 200 lb. per sq. in. pressure, and have been superheated in most cases. Often these boilers are on locomotives which have been converted from compound to single-expansion engines with new frames and relocated waist-sheet angle irons, pump bracket, braces, etc. Abandoned stud holes, which have been plugged, are often found in many locations. These boilers are, of

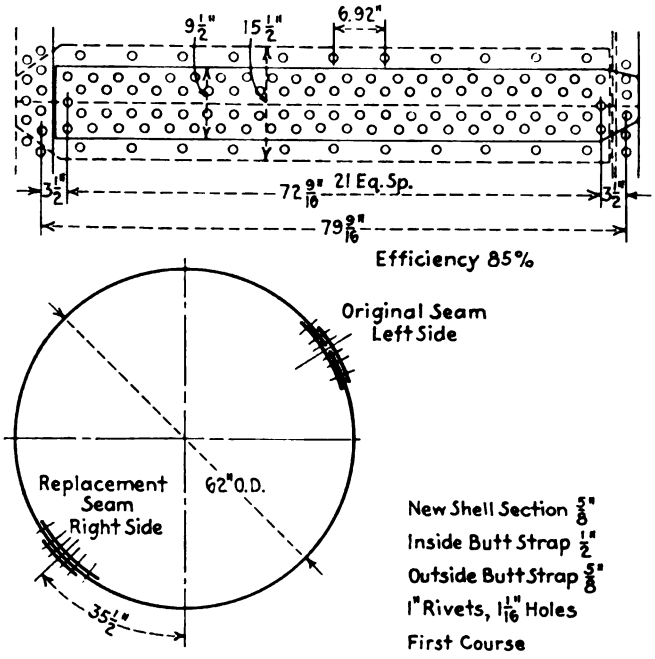


Fig. 1—A new bottom was applied to the first course of the boiler

course, required to have the same factor of safety as the boilers of new locomotives, and the boiler foreman is required to repair the boiler in the most economical manner consistent with good boiler practice.

The pitting and grooving of the shell courses of these older boilers is a case in point. The age and general design of the locomotive does not warrant the application of a new boiler shell, or even a single course in many cases, but the boiler must be put in proper shape for an indefinite period. During the past month a boiler of this kind was encountered, and was handled in the following manner.

A ten-wheel locomotive, built in 1900 as a Vauclain compound, came to the shop for classified repairs from an outlying point where the engine had been working for a number of years. After the flues were removed and the boiler scaled, the first course was found to be pitted along a strip 15 in. wide extending the full length of the course, and in one section about 10 in. wide extending transversely for a distance of 40 in. In addition, the interior of the shell, directly below the left boiler check, was defective and required patching. The defective portion of this course covered a large area and made any local reinforcement unsatisfactory. It was consequently decided to apply a new bottom to the course, duplicating the original seam on the opposite side of the boiler, as shown in Fig. 1. No change in stresses was caused by

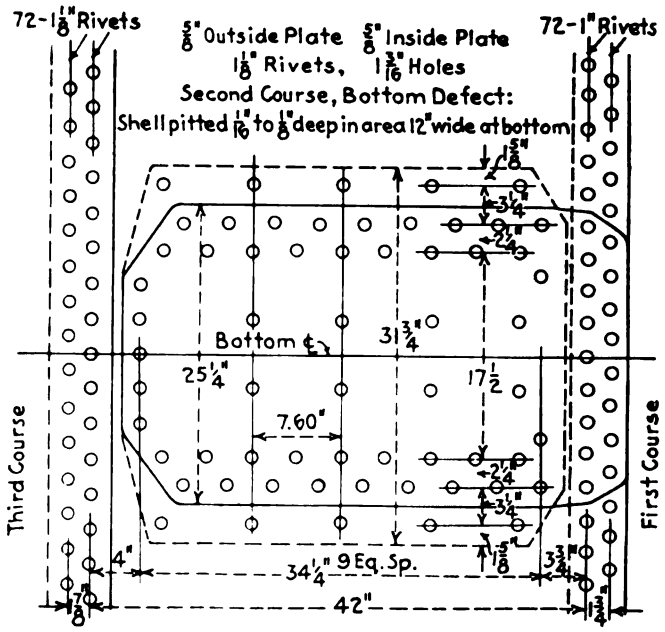


Fig. 2—The second course of the boiler was repaired by the application of wide inside and outside straps along the bottom center line

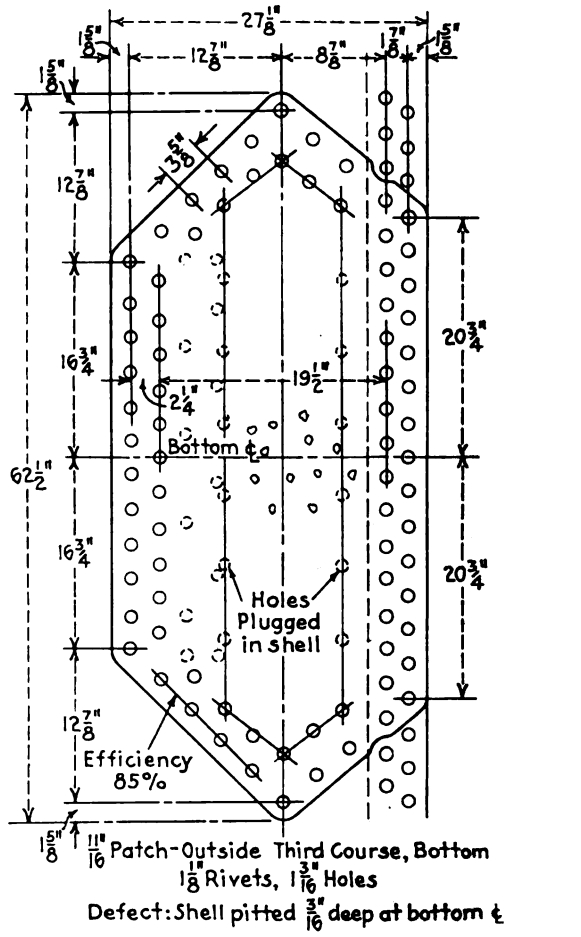


Fig. 3—The third course of the boiler was reinforced by a patch on the outside of the shell

* An entry in the prize competition on boiler patches, announced in the March, 1939, issue. The names of the winners were published in the August, 1939, issue. The author is general boiler foreman, Milwaukee locomotive shops, Chicago, Milwaukee, St. Paul and Pacific, Milwaukee, Wisconsin.

this repair, and the first course was restored to its original strength.

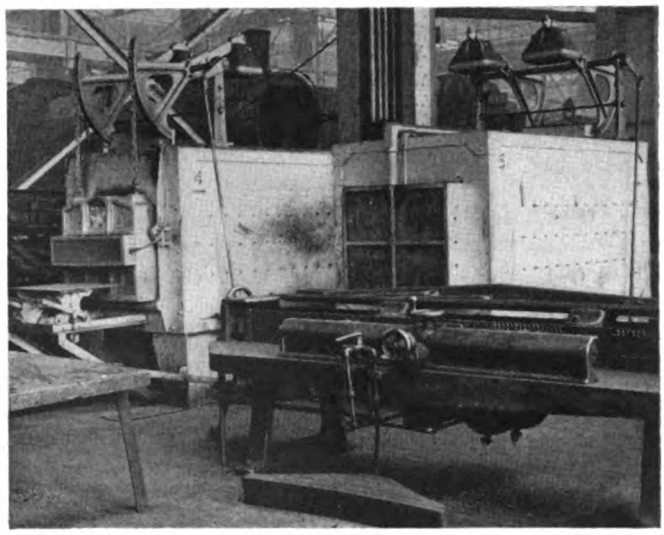
The second course of the boiler was tapered and rather short, and the shell was in good shape generally, except for scattered pits and some grooving at the back edge of the first course. The condition of this course did not warrant very extensive repairs, but could not be disregarded entirely. Repairs were made by applying wide inside and outside butt straps along the bottom center line of the boiler, as shown on Fig. 2. This reinforced the defective portion of the shell in a simple manner without increasing the shearing stress on rivets or the tension in the net section of the plate.

The third course sheet was badly pitted in an area about 20 in. in diameter along the bottom center line directly back of the second-course girth seam, and this condition was complicated by the presence of a number of abandoned stud holes which had been plugged at the time the engine was converted to single expansion. The rear portion of this shell course and the back flue-sheet braces, however, were in good condition, and it was not desirable to disturb these braces. The defective portion of this course was reinforced by applying a patch on the outside of the shell, taking in the entire defective portion of the sheet, and replacing the existing wear plate for the back waist-sheet angles. By making the plate efficiency of the diagonal seam equal to that of the longitudinal seam, the tension in the net section of plate was not increased. This repair is shown in Fig. 3.

Thus the entire boiler shell was returned to its proper strength in a simple and inexpensive manner, each course being treated as a separate problem, and repaired in a different way. While this boiler presented no particularly difficult or unusual condition, it is offered as an economical and satisfactory solution to a common problem confronting the boiler foreman.

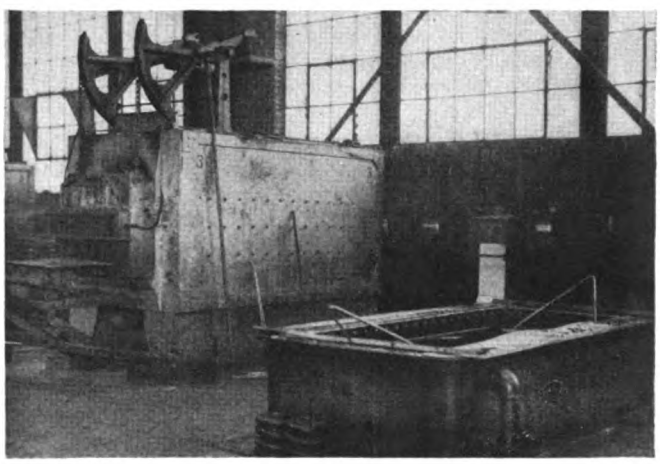
Reconditioning Carbon-Steel Springs

The equipment and methods employed at the Point St. Charles locomotive shops of the Canadian National to repair locomotive, tender, and coach springs has resulted in the production of springs of uniform quality and with a much greater service life than was obtained from springs made by former methods. The accurate control of the temperatures in the heat treatment of carbon-steel springs is furnished by electric furnaces and auxiliary equipment. Instead of attempting to heat treat the spring leaves immediately after forming them, the forming and heat treatment have been separated into two distinct operations. Also, a close check is made by test equipment to insure that each spring has the characteristics required by the specifications.

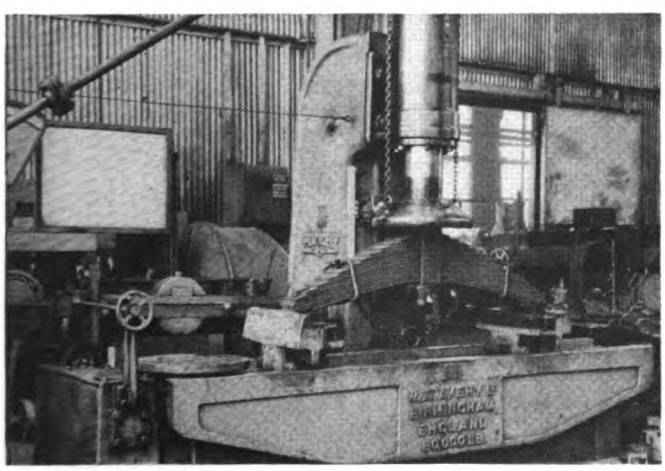


Spring forming machine and electric furnaces used in heating

The springs are first placed in the testing machine as shown in one of the illustrations and are checked for free height and deflections under load. If the springs meet the test requirements and have no defects, they are placed in a No-Ox-Id bath. This solution is at a temperature of 175 deg. F. and is both a rust preventative and a lubricant. Springs which do not meet the specifications are taken to the stripping machine where the spring bands are removed.



Electric furnace with control equipment and oil vat for heat treatment of the springs



The springs are checked in this testing machine

The spring leaves that are broken or worn are removed and replaced by new leaves. All the leaves of the entire spring are then placed in an electric furnace and are brought to a temperature of 1,600 deg. F. After heating, the leaves are reset on a spring-forming machine. To produce the proper camber and to insure that all springs are made uniform, a leaf from a master spring is inserted in the bending machine with each corresponding leaf of the spring being reconditioned.

The leaves are not heat treated directly after they are removed from the forming machine. They are allowed

to cool, after which they are placed in another electric furnace where they are heated to 1,550 deg. F. and then quenched in oil. The furnace temperature is controlled and recorded by an electric pyrometer. After quenching, the leaves are washed in a caustic solution to remove the oil. The next operation is to place the leaves in a third electric furnace in which they are heated to 725 deg. F.; they are then air cooled.

This operation completes the heat treatment of the springs and, as all the leaves of each spring have received the same treatment in each successive operation, the uniformity of the springs is insured. For this reason, only one leaf from each heat is tested in a Brinell testing machine and checked for the required hardness of 387 Brinell.

The spring leaves are sent next to the spring-banding machine where the bands are applied. Here too, the bands are heated in an electric furnace. The spring is next marked for identification with the proper letter symbols and the date. The completed spring is placed in the No-Ox-Id bath and from here it is again taken to the testing machine where it must meet the specifications for that particular spring.

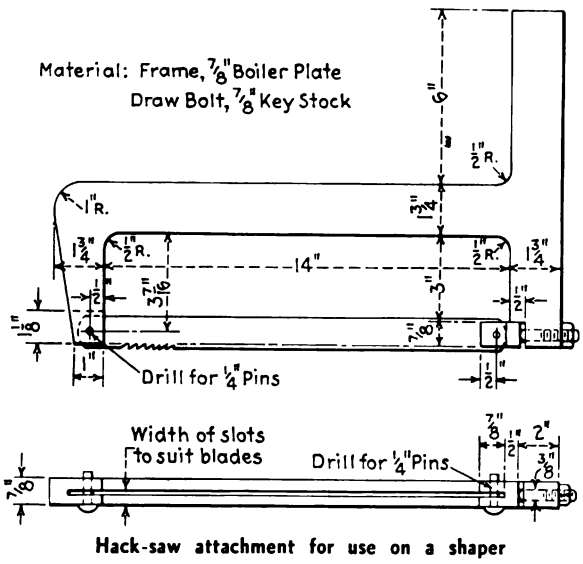
Slotting Rod Bushings On a Shaper

Slotting locomotive rod bushings may be done quickly and economically on a shaper with the hack-saw attachment shown in the illustration. This device is being used to advantage on a southwestern railroad, resulting in a saving of time over other methods and relieving milling machines for more important work.

The conventional power hack saw found in most shops is not suitable for this work because of the limited stroke adjustment and the fact that the design of the vise for holding the work is not adapted to this particular job.

The attachment replaces the ordinary tool in the shaper and is fastened in the usual way except that it must be set accurately vertical. The work is held in the vise or by other suitable means and the saw fed into the work by hand. The stroke is set to the maximum commensurate with the length of the work. High-speed-steel blades with a coarse pitch produce the best result.

The device is a practical shaper accessory and may be used in connection with other operations on the shaper which will suggest themselves to the man in the shop.

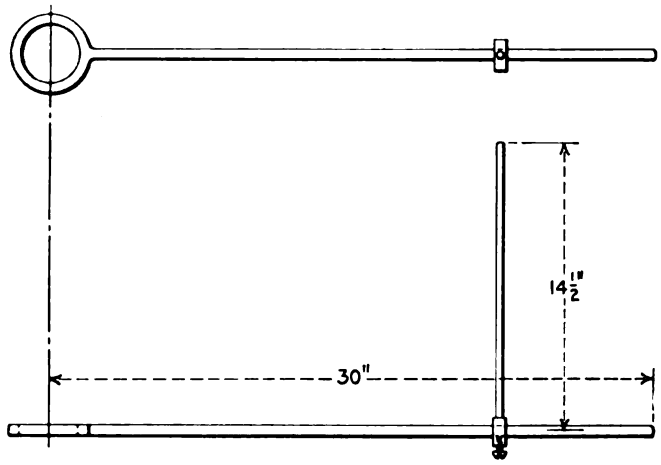


Hack-saw attachment for use on a shaper

Gaging the Length Of Locomotive Drawbars

By A. D. Hollis

The simple gage shown in the drawing is not as widely used as its usefulness would justify. To check the length of a locomotive drawbar before it is applied, or to tell the blacksmith shop foreman the length to which it should be adjusted, a dummy wooden pin the same



Gage for measuring drawbar lengths

size as the usual draw-bar pin is used through the round hole in the end of the gage. It is placed in the position the drawbar will occupy first on the tank and then on the locomotive, or vice versa, with the buffer and its wedge in the desired position. It is held level with the short arm contacting the buffer surface. After adjusting the short arm to suit, this length is measured with a rule and noted. One measurement is obtained for the locomotive and another for the tank and the sum of these two dimensions will be the proper drawbar length. If this gage is used it will seldom be necessary to remove a heavy drawbar and change the length after attempting to couple a locomotive and tender together.

Instructions for Maintaining Diesel-Electric Equipment

In the April issue of *Railway Mechanical Engineer*, there appeared on page 131, an abstract of a paper by H. V. Gill, supervisor of Diesel locomotives, Atchison, Topeka & Santa Fe, on the design, operation and maintenance of Diesel-electric locomotives. In that paper mention was made of a special instruction bulletin covering the inspection and maintenance of road and switching locomotives as reported on Forms 1226-D and 1226-DS appearing on pages 133 and 134. These instructions are reprinted here for the benefit of our readers.

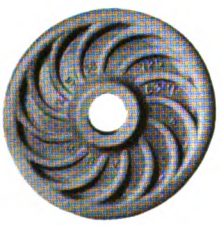
Diesel Fngines

Crankcases—Diesel engine crankcases should be examined carefully for loose or broken main bearing studs or bolts; loose-bearing caps; loose main bearing lower supports; loose main bearing jacks; cracks in engine frame or in bearing supports; broken or loose oil lines, or oil distribution manifolds; missing lock wires or cotter keys. Observe closely the condition of the lower part of the cylinder liners and pistons for cracks, scored condition and pieces broken out.

(*Continued on next left-hand page*)



The low coefficient of rail abrasion of chilled iron wheels not only reduces wear of rails but, materially decreases train resistance and makes another important contribution to economy of operation.



4 Savings with Chilled Car Wheels:

❶ Increased rail life. ❷ Reduced machine shop costs.

❸ Lowest cost per mile. ❹ Increased brake shoe life.

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Connecting rods should be examined for loose bolts or studs; loose bearings in the connecting rod; missing cotter keys; excessive bearing wear as indicated by the lowering of the connecting rod. Any indication of bent condition or misalignment of rod should be corrected. No chances should be taken with crankshafts, or crankshaft bearings or bearing supports as serious damage to the engine will be the result.

Any indication of bearing metals that have pounded out, or flaked out, or where fine particles of bearing metal has been thrown out into the crankcase must be investigated carefully. The defective bearing should be located and removed.

During crankcase inspection attention should be given to any gaskets, or other conditions that would be causing, or cause lubricating oil to leak from parts of the engine. Also note if water or air is leaking into the crankcase by seal rings or cylinder liners.

Any unusual noise in the blowers, gear trains or timing chains should be investigated and repaired.

Injection Timing—The timing of the fuel pumps or fuel injectors should be carefully checked to be sure the injectors are properly set to start the injection of the fuel charge at the proper time according to instructions covering the type of engine used.

Injection Control Linkage—Injection control linkage should be properly adjusted so that all injector racks will be opened and closed uniformly and that no cylinders will have excessive rack travel in full-load position. Consult instructions for details covering each particular type of Diesel engine.

Cylinder Head Valve Lash Adjusters or Valve Clearances—Engines using automatic exhaust valve lash adjusters should have these checked for proper contact with the valve stem cap and to make sure that the cams are in the proper position.

Engines using valve clearance, on exhaust and intake valves, should have these checked to be sure the clearance conforms with the instructions for each particular type of engine.

While cylinder head covers are off for valve clearance check the rocker arm assembly, and all other parts under the cover should be examined for good condition. Any leaky gaskets, or fuel leaks, should be repaired and reported.

Cylinder Heads for Leaky Valve—Test of cylinder heads for leaky valves may be made with the engine running at slow speed. Any valves found worn, sticking or blowing should be removed and the condition corrected.

V-Belt Drives—All V-belt drives should be inspected for loose pulleys, worn grooves in the pulley, loose or defective belts, loose or worn flexible couplings. V belts drive the most important auxiliaries to the power plant, such as air compressor, traction-motor blower, cooling fans, boiler-water pumps and blower. Any defective condition should be corrected.

Flush Engine Cooling System—Flushing of the engine cooling system may be done by circulating a recommended chemical solution for the proper length of time, or by using clear water. When chemicals are used proper record should be made on a form stating the chemical used and if water treatment is used this should also be recorded. Special instructions covering the kind of chemical used should be closely followed. (No chemicals or water treatment should be used unless approved).

Fuel System Piping—Fuel tank and connecting piping must be carefully examined for loose pipes that may chafe against other parts of the locomotive, pipes not properly clamped, leaky or not properly secured fuel tank and leaky pipe joints. Any condition that would create a fire hazard should be corrected at once.

Safety Cut-Off Valve on Fuel System—The safety cut-off valve in the fuel system should be tested to be sure it properly cuts off the flow of fuel. This should be handled by breaking a pipe joint in the line of discharge side of the fuel pump and not by tripping the cut-off valve, thus allowing the engine to starve for fuel. The injector plungers are a very close fit in the barrels and depend upon the fuel for lubrication. If the fuel supply is shut off, scoring and seizing of the injectors will result.

Fuel Pumps—Fuel pumps should be checked for leaky condition, tight on base, condition of drive. There should be no binding of the motor or fuel pump but it should turn freely. The pump may be checked for capacity by noting gage pressure and noting the amount of excess fuel being returned to fuel tanks.

Piston Inspection—Pistons should be inspected through the air-box openings or through the crankcases for scored skirts, burned heads, stuck rings, broken rings or correct ring tension, excessive gap openings in rings indicating wear, water leaks in cylinder, proper lubrication of cylinder walls and any indication of defective condition should be corrected before the Diesel engine is returned to service.

Lubricating Oil System—The lubricating oil system should be maintained in first-class condition, free from all leaks. Check carefully for leaky joints and improperly secured pipes. If low pressure is indicated on the gage, a thorough investigation should be made and loss of pressure corrected. Otherwise expensive damage may be done to the engine.

Drain Sediment From Fuel Tanks—Each tank is equipped with a sump which has a drain plug in the bottom. This drain plug has a stop on it that prevents its being completely removed. The vent of the drain plug has a drain hole through which water and sediment is drained from the fuel tank. Careful attention should be given to the operation to keep the water and sediment drain out of the fuel tanks as both will damage the fuel injectors and may result in complete failure of the Diesel engine.

Inspection of Timing Chains or Timing Gears—Where silent chains are used they should be inspected for cracked side bars, broken rollers, proper tension—chain may be too loose or too tight. If found loose or tight, the automatic slack takeup assembly should be inspected for proper operation. Chains may be inspected through inspection openings in the housing by baring the engine over slowly.

The timing gears may be inspected through inspection openings for broken teeth or excessive wear of the teeth.

Any noisy condition of the timing chains, or timing gears, should be investigated to prevent damage.

Check Injectors for Tightness—Individual injector assemblies or injection fuel pump assemblies should be inspected for tightness in cylinder heads and for loose or defective condition of mounting brackets. Where drive shafts and couplings are used on Bosch system these should be included in the above inspections. High-pressure fuel lines must be given special attention.

Water Pumps—Water pumps should be examined for loose impellers, worn bearings, corroded impellers, leaky conditions at water seals or packing glands. Any condition that has been reported on the water system should be thoroughly investigated. The first item to be checked should be the water pump to be sure the pump is properly circulating water through the system.

Main Governor—Woodward hydraulic governors are used on Diesel engines for speed control and it is imperative that these devices be kept very clean. The same oil as used in the crankcase of the Diesel engine is used in the governors. Governor oil seals should be renewed when leaking and the governor flushed out or adjusted or repaired whenever reported as operating improperly.

The following practice should be followed when flushing out the governor: drain out the oil; fill with clean fuel oil; open both surge control valves; run the engine at idle speed for one minute; stop the engine and drain out the fuel oil; fill with clean, new oil and run the engine at a little above idling speed for one minute; drain out the oil and apply fresh, clean oil; start the engine and adjust the governor surge control valve.

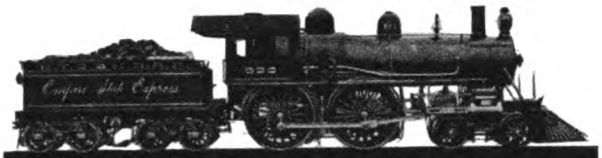
If necessary to dismantle the governor, this operation should be handled by a competent repairman only after a thorough study of the instruction manual has been made. Extreme care must be taken to have all parts perfectly clean before the governor is reassembled.

Overspeed Governors—The overspeed governors must be kept clean and repaired whenever reported as erratic in operation. Where Woodward type governor is used, the same oil as used in the Diesel engine crankcase should be used. When the main engine governor is flushed out or cleaned the overspeed governor should also be cleaned.

Cooling Radiators and Connecting Piping—Radiators and connecting piping should be inspected for leaks, defective hose connections, accumulation of dirt in between or around the radiator tubes or fires. If loss of radiator water has been noted, or reported, and no leaks are found, it will be necessary to check the engine cylinders for defective gaskets or cracked cylinder liners or cracked cylinder head.

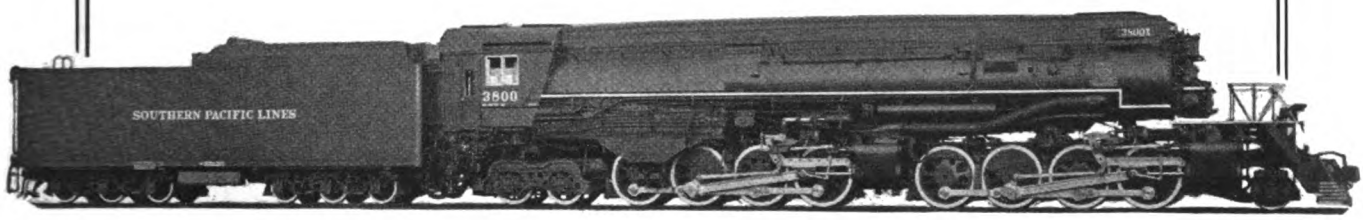
If oil is found in the cooling water system, it will be necessary

(Continued on next left-hand page)



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to locate the source of the oil leak and correct the condition. Oil leak into cooling water will generally be from the oil cooler.

Blow Out All Radiators—Radiators may be blown out using clean, dry air. On engines with radiators mounted in a well, attention should also be given to keep dirt, cinders, etc., from accumulating and building up around the radiator.

Inspect Coupling Between Diesel Engines and Generators—Flexible coupling which connects the Diesel engines to the generator should be carefully inspected for loose or broken drive studs, broken discs, noisy operation or coupling which indicates misalignment. Any indication or defective condition should be investigated and corrected.

Main Crankshaft Bearings—Should be removed and examined at the time of the annual inspection on switching locomotives. The main crankshaft bearings should be examined on passenger road locomotives every 100,000 miles of service. The three center main bearings should be removed and closely inspected, and if found in good condition, the balance of the bearings may be continued in service without removing them. If the center main or adjacent bearings are found in bad condition, all bearings should be removed. At the end of 300,000 miles of service, all main bearings should be renewed for inspection on road locomotives.

Connecting Rod Bearings, Crankshaft End—Should be closely inspected when the pistons are removed, special attention should be given to the upper half of the connecting rod bearing in two-cycle engines. Any bearing that shows indications of pitting, flaking, cracking, or indications of bearing shell coming in contact with the journal must be renewed to avoid damage to the crankshaft.

[NOTE—Additional sections of the instruction bulletin cover electrical equipment, lubrication and cleaning. These will appear in later issues—Editor.]

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

The Application of Front Tube Sheets by Welding

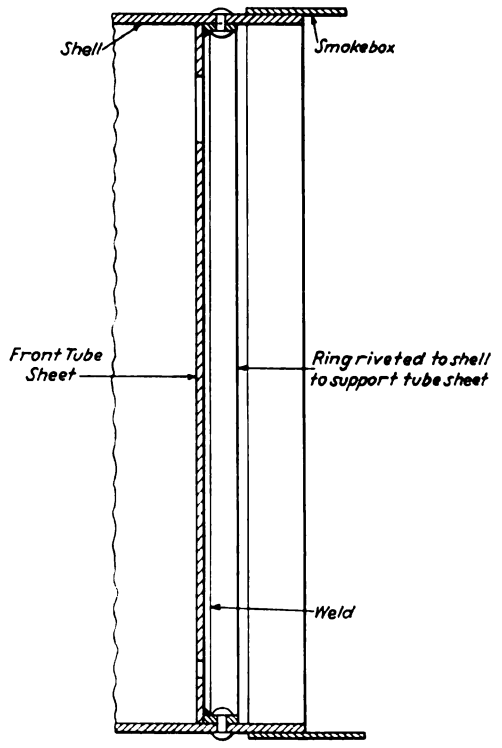
Q.—We are having considerable trouble with the knuckles of our front tube sheets cracking and have been advised to weld the tube sheets into the shell, omitting the flange. Is this being done?—H. G. D.

A.—There are several methods of applying front tube sheets by welding and thus eliminating the flanged knuckle, but in no case is the tube sheet welded to the shell of the boiler.

The illustration shows a method of applying a front tube sheet by welding which can be applied to new work or repairs. It consists of a ring riveted to the inside of the shell, with the front tube sheet set inside of the ring and welded to the ring from the smokebox side.

For repairs the present flange on the tube sheet should be allowed to remain in the boiler by burning out the old tube sheet at the knuckle. The remaining flange or ring should then be chipped smooth for the application of the new tube sheet.

The new tube sheet is passed into the boiler by notching out the ring at each side on the center line of the boiler a sufficient amount to allow the new tube sheet to pass through.



A method of applying the front tube sheet by welding

Reinforcing a Circumferential Groove in a Boiler Shell

Q.—Will you be good enough to give me what you consider an efficient method of patching a circumferential groove 3/8 in. deep by 1 in. wide by 30 in. long in a shell having a plate thickness of 9/16 in.? An example of this type of grooving was shown on page 238, August, 1930, issue of the "Boiler Maker."—E.A.B.

A.—The ends of the patch should be designed as a half diagonal patch. The spacing of the outside row of rivets should be determined from the formula:

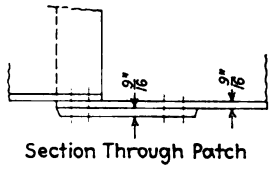
$$E = \frac{2\,(P - d)}{P\,\sqrt{3 \sin B + 1}}$$

where

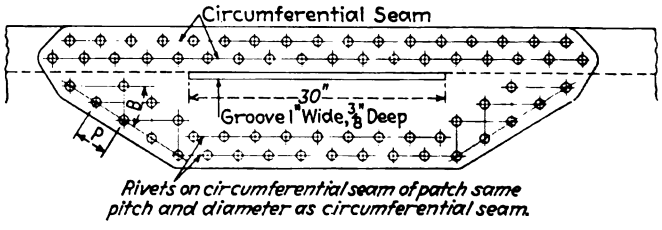
E = efficiency, per cent.
P = pitch of rivets in outside row, in.
d = diameter of rivet hole, in.
B = angle of outside row of rivets as illustrated, deg.

The thickness of the patch should be the same as the

(Continued on next left-hand page)



Section Through Patch



A method of patching a circumferential groove in a boiler shell

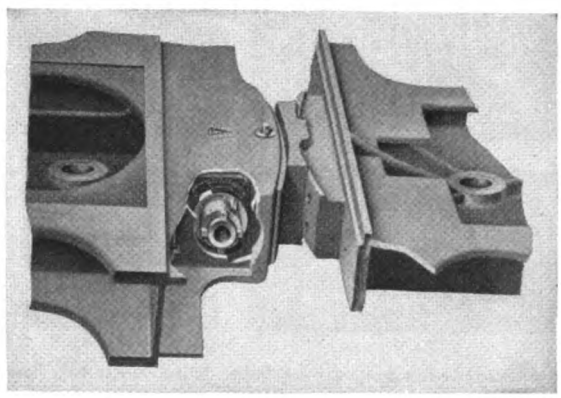
97.7%

of the steam locomotives purchased in 1939

HAVE

FRANKLIN E-2 RADIAL BUFFERS

97.7% of the steam locomotives purchased during 1939 for use in the United States are assured of easier riding and greater safety. Slack between engine and tender is eliminated by the application of the Franklin E-2 Radial Buffer, thus absolutely removing one of the principal causes of hard riding. » » » The Franklin E-2 Radial Buffer quickly pays for itself . . . in economy . . . in safety . . . in increased passenger comfort . . . and in lower maintenance.



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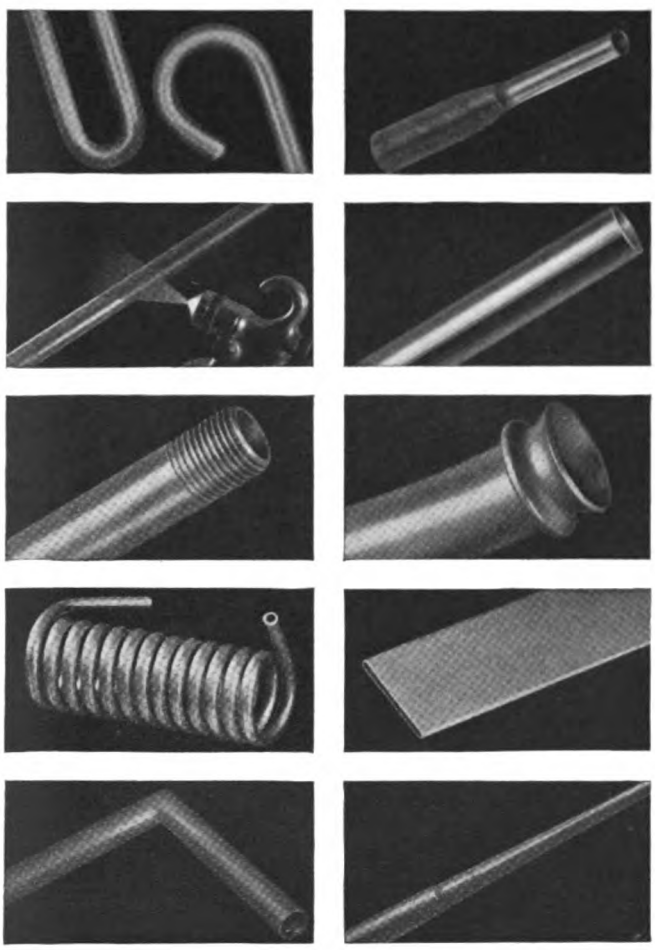
NEW YORK CHICAGO MONTREAL

thickness of the shell course to which it is attached. The size of the patch will be determined by the design of the ends of the patch required to give the proper efficiency.

Tubing of Carbon and Alloy Steel

The development of Agalloyed steel tubing, said to be comparable in quality and appearance to cold-drawn seamless tubing, has been announced by the AGA Metal Tube Company, Elizabeth, N. J. The tubing is produced by joining spirally wound cold-rolled steel strip in the hydrogen atmosphere of a high-frequency induction furnace.

The tubing can be made in all straight carbon steels as well as in chrome vanadium, chrome nickel, and chrome molybdenum steels. The sizes manufactured at present range from 1/8-in. to 5/8-in. outside diameter with wall thicknesses ranging from .010 to .042 in. It is claimed that the tubing has a very uniform wall thickness as it is manufactured from cold-rolled strip steel, and the close strip-steel tolerances are maintained in the finished tubing. The tubing is available in various tempers to meet particular requirements. It is furnished cold drawn and can be bent, coiled, expanded, flared, swaged, spun, machined, or welded as shown in the illustration. It will stand severe forming and with but little preparation, the surface is ideal for plating.



Agalloyed steel tubing can be bent, coiled, expanded, flared, flanged, swaged, spun, machined, or welded

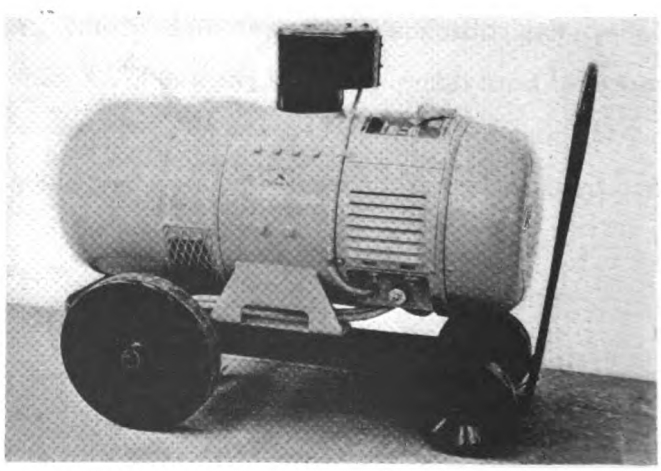
The average physical properties of annealed tubing produced from S. A. E. 1010 low-carbon-steel strip are as follows: Yield point, 27,000 to 30,000 lb. per sq. in.; tensile strength, 47,000 to 50,000 lb. per sq. in.; elongation, 38 to 42 per cent in 2 in., and reduction of area, 60 to 68 per cent. Hard-drawn tubing made from the same steel will have a tensile strength of 80,000 to 85,000 lb. per sq. in. It is possible in high-carbon and alloy-steel tubing to obtain tensile strengths in excess of 200,000 lb. per sq. in. by heat treating in a conventional manner. The tensile strength of the tubing, in any case, is always the same as the parent metal from which the tubing is made.

Remote Control for Arc Welders

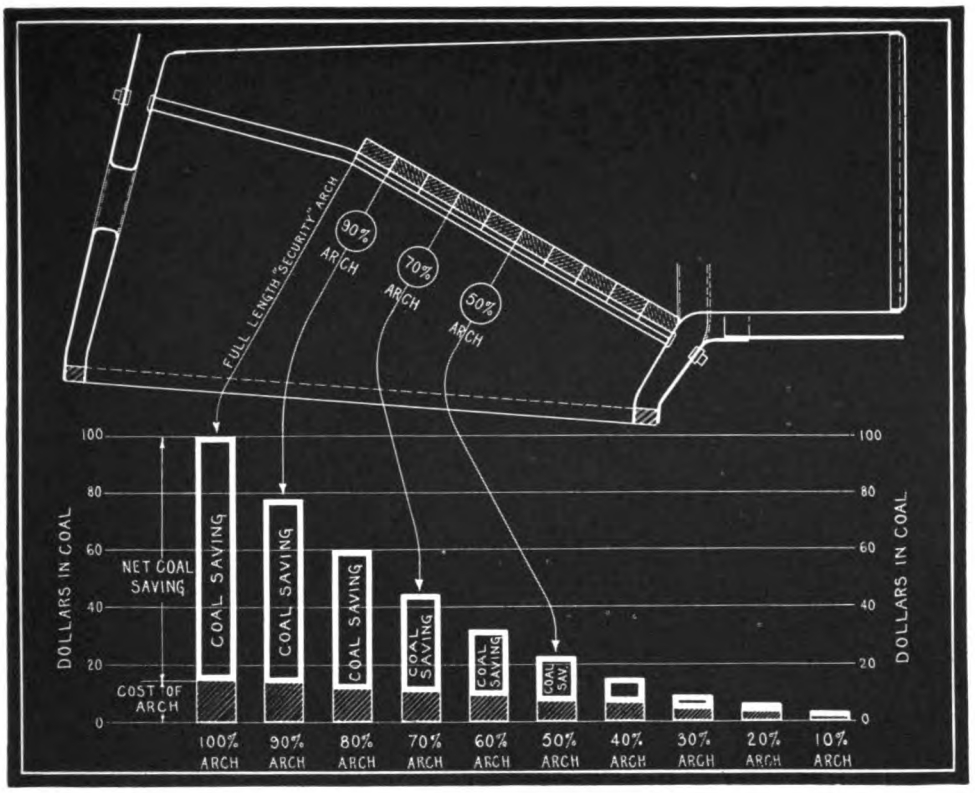
A new device for the remote control of arc welders has been announced by the Wilson Welder and Metals Company, Inc., New York. The single control of the Hornet and other Wilson arc welders is well adapted to operation by this method. To utilize this control, the handwheel which governs the control pole of the standard welder is simply replaced by the reversible motor-driven Type SC remote-control device.

It is said to cover the entire range of the machine to which it is attached in both high and low settings. The device allows minute adjustments in the current output to be made by merely touching one of two contacts on the electrode holder to the ground. When the electrode-holder button marked "more" is brought into contact with the ground, the electric motor in the remote control housing on top of the machine revolves and raises the control-pole core, increasing the output. The motor revolves only while the actual contact is maintained. When the button marked "less" is grounded, the remote control motor revolves in the opposite direction and lowers the control-pole core, decreasing the output. The contact points are shaped differently so the operator can easily locate the correct one even with poor illumination.

The 1/80-hp. electric motor, which is all that is required to operate the control pole, is protected by two limit switches and by a slip clutch to prevent damage when the end of the range is reached. The generator may be preset by push buttons mounted on the control itself.



The Wilson "Hornet" arc-welding generator equipped with the Type SC remote control for adjusting current output



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With the emphasis being placed on saving every railroad dollar, the locomotive Arch becomes increasingly important.

Regardless of the amount of traffic handled, the locomotive Arch saves enough fuel to pay for itself ten times over.

Be sure that every locomotive leaving the roundhouse has its Arch complete with not a single brick nor a single course missing.

In this way, you will get more work for each dollar of fuel expense. Skimping on Arch Brick results in a net loss to the railroad.

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Railway Affairs . . .

Wages Up

In the so-called boom year, 1929, the average annual compensation of the maintenance of equipment and stores employees was $1,668. Five years later, in 1934, in the heart of the depression, it had fallen to $1,341. A decade later in 1939, when business in this country was none too good and unemployment still at the high point, this average compensation had increased to $1,736. The average maintenance of equipment and stores employee, therefore, drew $68. more during 1939 than in 1929 and the dollar would purchase much more in 1939. Unfortunately, however, fewer employees were required in 1939 than in 1929 and the total wages paid was therefore less, although they were about the same percentage of the total operating revenues of the railroads as in 1929.

Low Passenger Fares For New York World's Fair

In spite of wars and rumors of war, the New York World's Fair is preparing for a still more elaborate and ambitious program for this, its second season. The Trunk Line Association railroads are making special rates for the duration of the Fair, well below those which were in effect last year. These special rates vary according to the distance, return-time limit and party-quantity. The minimum rate is .75 cents per mile for parties of 25, under the age of 18, who may make a one-day visit to and from the Fair from any point in trunk line territory. Another example of an extremely low rate is that for round-trip coach fares for parties of 300, which are based on a general one-cent per mile rate in each direction, or for parties of 500 or more, which are on a general basis of .85 cents. Still greater reductions are available for school children.

Double-Heading Forbidden

Double-heading and pushing have been common features of railway operation in every country of the world on all kinds of trains, and with every form of motive power, since the earliest days of railroading. The number of accidents definitely traceable to these practices is but an infinitesimal percentage of the number due wholly to carelessness or neglect on the part of train and engine crews. In spite of this, and possibly influenced by the approaching primary elections, the State Railroad Commission of Texas has issued an order prohibiting the use of two motive power units on one train, except under special permits allowing additional power to move trains over steep grades. The Commission held a hearing, at which representatives of the trainmen's unions testified that double-headers had caused accidents and serious injuries, although the company officials insisted that such operations were not hazardous, but were in the interests of economical operation.

Moral Rearmament

Dictators drunk with power and regardless of the welfare of humanity, are bringing dire disaster to many nations and millions of people. The whole world seems to be delicately balanced on the brink of chaos It behooves us in this favored land to examine our own attitudes and actions critically. Is not too much of this spirit of dictatorship evident in the dealings between various groups and classes in this country? The action of the Railway Labor Executives' Association in passing a resolution on "moral rearmament" is greatly to be commended. The preamble includes the statement: "It is an easy matter to lay the blame on others and to refuse to walk the straight path of personal responsibility. But the times demand an honest facing by every man and every nation of their own guilt in our common crisis." The resolution, which was unanimously adopted, reads as follows: "One of the most baffling questions before this nation today is how to break the vicious circle of bitterness that commonly enters all negotiations between groups having conflicting interests. Our greatest need is for the rise of a new spirit that will replace that bitterness with creative planning for national unity. For that change, labor has a joint responsibility with all other groups of our citizens, and we are convinced that the time has come to face it squarely on the principles of moral rearmament. Accordingly, we pledge ourselves to help labor find its place of moral leadership in American life, and set a pattern of co-operation within its own ranks."

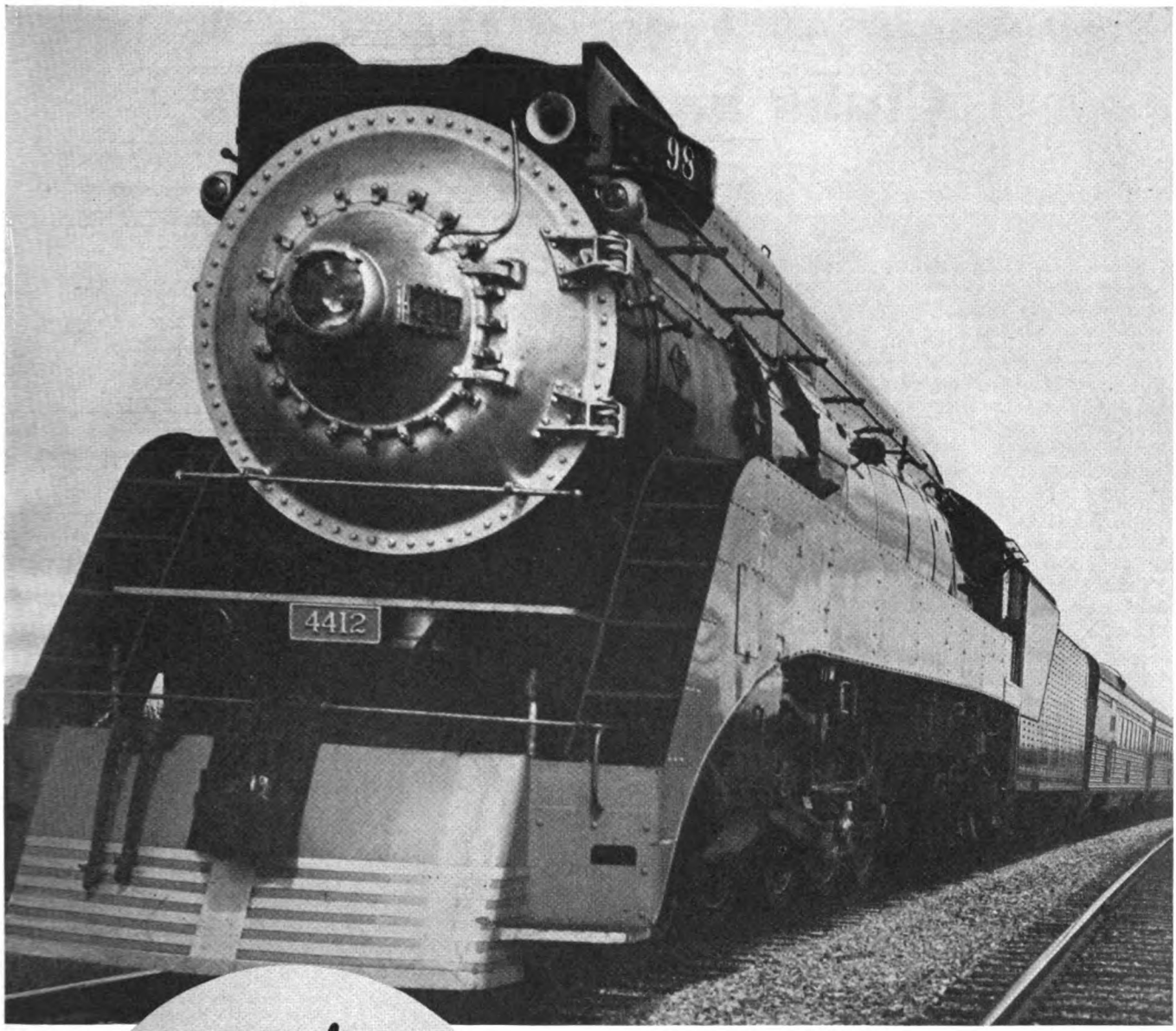
Suggests Waterway Tolls

There has been a growing sentiment in favor of charging tolls for waterways which are maintained at public expense. Even President Roosevelt has voiced such a recommendation. Now comes Mr. Eastman's subsidy report, which includes a somewhat similar recommendation, although, it is true, he treads a bit lightly on this troublesome ground. "I would not at the start advocate in most instances," he said, "fully compensatory tolls, but only such as it is believed the traffic will be able to bear, leaving future tolls to be determined in the light of experience." It is too bad, is it not, that the same sympathetic consideration has not been extended to the railroads—the neglected orphans of transportation? Mr. Eastman does make another statement in the report with which we are in cordial agreement. "It may be conceded," he says, "that the introduction of more efficient or economical means of transportation ought not to be prevented to save existing carriers from injury, for otherwise progress would be stopped. *However, in determining whether a new means of transportation is actually more efficient or economical, plainly all the costs which are incurred in making it available must be taken into consideration, and not a part of them only.*"

(*Turn to next left hand page*)

Railroad Labor Appears Before T. N. E. C.

As was to be expected, railroad labor presented its views before Senator O'Mahoney's Temporary National Economic Committee. George M. Harrison, president of the Brotherhood of Railroad Clerks, was its spokesman. President A. F. Whitney of the Brotherhood of Railroad Trainmen is expected to appear later on. Among other things, Mr. Harrison said that railroad labor wanted to see a return to a traffic level that would sustain at least 1,600,000 jobs, or about 600,000 more than are now available. In answer to a question, he said he believed this could be done if the government ceased its policy of giving subsidies to the railroads' competitors. In his earlier testimony, however, Mr. Harrison ascribed a considerable loss of jobs to the extensive use of labor saving devices. In the discussion which followed his formal presentation he was keenly critical of the railroads in losing business to the trucks, because of an alleged lack of initiative. In his opinion a mistake had been made in continuing the use of large cars and heavy locomotives. These should be replaced by smaller and lighter cars and more frequent schedules. That his own organization had some misgivings about the future of the railroads is indicated by his statement that not one dime of his organization's funds is invested in railroad securities—an interesting point of view when one considers the claims of some of the labor leaders that railroad workers, now regarded as this country's most favored labor group, are suffering at the expense of the railroad owners, many of whom have almost literally "lost their shirts."



127 million passenger miles during 1939

The "Daylights", streamlined steam trains of the Southern Pacific, covered 127,121,322 passenger miles for the year ending June 30, 1939. This passenger traffic resulted in the "Daylights" earning $3.85 per train mile, which is believed to be the highest net passenger revenue for streamliners. « « « Fast schedules call for high sustained boiler horsepower. The 4-6-4 locomotives hauling the "Daylights" are equipped with Elesco type "E" superheaters to provide maximum boiler horsepower. Modern power deserves the best in superheater equipment . . . Elesco . . . hence the selection of the type "E" for this service.

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Among the Clubs and Associations

NEW ENGLAND RAILROAD CLUB.—Annual banquet and entertainment 6:30 p. m., May 14, Copley-Plaza Hotel, Boston, Mass.

CANADIAN RAILWAY CLUB.—Meeting 8:15 p. m., May 13, Rose Room, Windsor Hotel, Montreal, Que. Speaker: H. Eckhardt, advertising expert, Kenyon & Eckhardt, New York. Subject: "First Get 'em To Listen."

PURCHASES AND STORES DIVISION, A. A. R.—The annual meeting of the Purchases & Stores division, Association of American Railroads, will be held at the Pennsylvania hotel, New York, on June 25 and 26.

NORTHWEST CAR MEN'S ASSOCIATION.—Meeting 8 p. m., May 6, Midway Club Rooms, St. Paul, Minn. Speaker: W. E. Gleb, coach shop foreman, Northern Pacific. Subject: Air Conditioning of Passenger Cars.

RAILWAY CLUB OF PITTSBURGH.—Meeting April 25, Fort Pitt Hotel, Pittsburgh, Pa. Speaker: G. O. Wedell, manager, Pittsburgh branch, York Ice Machinery Corporation, York, Pa. Subject: Air Conditioning.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—Meeting 1:30 p. m., May 9, general car foreman's office, Union Pacific, Council Bluffs, Iowa. Election of officers.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.—Regular meeting 8 p. m. May 21, Hotel DeSoto, St. Louis, Mo. Speaker: Noreus H. Roy, director of research, Waugh Equipment Company. Subject: The Draft Gear of Today—and Tomorrow. Twenty-minute motion picture, "Tomorrow's Railroads," with sound. Get-together dinner at 6:30 p. m. Morning meetings will also be held at the Broadview Hotel, and at the E. St. Louis, Mo. Lion's Club of E. St. Louis, followed by a luncheon at 12 o'clock.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

AIR BRAKE ASSOCIATION.—R. P. Ives, Westinghouse Air Brake Company, 3400 Empire State building, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION.—J. F. Gettrust, P. O. Box 5522, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—C. E. Davies, 29 West Thirty-ninth street, New York.

RAILROAD DIVISION.—C. L. Combes, Railway Age, 30 Church street, New York City.

MACHINE SHOP PRACTICE DIVISION.—Warner Seely, Warner & Swasey Co., 5701 Carnegie avenue, Cleveland, Ohio.

MATERIALS HANDLING DIVISION.—F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

OIL AND GAS POWER DIVISION.—W. J. Hargest, American Machinist, 330 West Forty-second street, New York.

FUELS DIVISION.—A. R. Mumford, Consolidated Edison Co., 4 Irving Place, New York.

ASSOCIATION OF AMERICAN RAILROADS.—Charles H. Buford, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

OPERATING SECTION.—J. C. Caviston, 30 Vesey street, New York.

MECHANICAL DIVISION.—V. R. Hawthorne, 59 East Van Buren street, Chicago. Meeting Stevens Hotel, Chicago, June 27 and 28.

PURCHASES AND STORES DIVISION.—W. J. Farrell, 30 Vesey street, New York. Meeting June 25 and 26, Pennsylvania Hotel, New York.

MOTOR TRANSPORT DIVISION.—George M. Campbell, Transportation Building, Washington, D. C.

CANADIAN RAILWAY CLUB.—C. R. Crook, 4468 Oxford avenue, N. D. G., Montreal, Que. Regular meetings, second Monday of each month, except June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.—J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, DeSoto Hotel, St. Louis, Mo.

CAR DEPARTMENT OFFICERS' ASSOCIATION.—Frank Kartheiser, chief clerk, Mechanical Dept., C. B. & Q., Chicago. Annual meeting October 22-25, Hotel Sherman, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month.

CENTRAL RAILWAY CLUB OF BUFFALO.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday of each month, except June, July and August, at Hotel Statler, Buffalo.

* * *



Photo by C. Parker

Sunset over the Boston & Albany yards at Boston, Mass.

EASTERN CAR FOREMEN'S ASSOCIATION.—Roy MacLeod, Room 127, General Office Bldg., N. Y., N. H. & H., New Haven, Conn. Regular meetings, second Friday of January, February, March, April and October at Engineering Societies Bldg., 29 West Thirty-ninth street, New York.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—See Locomotive Maintenance Officers' Association.

LOCOMOTIVE MAINTENANCE OFFICERS' ASSOCIATION.—J. E. Goodwin, general foreman, locomotive department Missouri Pacific, North Little Rock, Ark. Meeting Hotel Sherman, Chicago, October 22-25.

MASTER BOILER MAKERS' ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y. Annual meeting October 22-25, Hotel Sherman, Chicago.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Thursday in each month, except June, July, August, September and December at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, 1931 University avenue, St. Paul.

NORTHWEST LOCOMOTIVE ASSOCIATION.—G. F. Greenleaf, chief clerk to mechanical engineer, Northern Pacific, St. Paul, Minn. Meeting last Monday of each month, except June, July and August.

PACIFIC RAILWAY CLUB.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Monthly meetings alternately in northern and southern California.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION.—T. Duff Smith, 1255 Old Colony building, Chicago. Annual meeting, October 22-25, Hotel Sherman, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

TORONTO RAILWAY CLUB.—D. M. George, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto, Ont.

TRAVELING ENGINEERS' ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

VALLEY ANTHRACITE CAR FOREMEN'S ASSOCIATION.—P. P. Kohl, executive secretary, 254 Barney street, Wilkes-Barre, Pa. Regular meetings third Monday of each month.

WESTERN RAILWAY CLUB.—W. L. Fox, executive secretary, Room 822, 310 South Michigan avenue, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

NEWS

House Passes Bill to Change Titles of Locomotive Inspectors

FOLLOWING through on the Senate's favorable action of April 10, the House of Representatives on April 15 passed and sent to the President the bill (S. 3440) which changes the titles of the chief inspector and assistant chief inspectors of locomotive boilers, respectively, to director of locomotive inspection and assistant directors of locomotive inspection. H. R. 8510, an identical bill which had been reported favorably from the House committee on interstate and foreign commerce, was laid on the table.

The Interstate Commerce Commission has favored the change because of the existing confusion and misunderstanding caused by the fact that the heads of all I. C. C. bureaus, save the Bureau of Locomotive Inspection, have the title of director.

Equipment Depreciation Orders

EQUIPMENT depreciation rates for the Louisiana & Arkansas, the Campbell's Creek and the Helena Southwestern have been prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15100, Depreciation Charges of Steam Railroad Companies.

Prescribed rates for the L. & A. are as follows: Steam locomotives—new, 3.19 per cent, secondhand, 6.93 per cent; freight-train cars—new, 3.1 per cent, secondhand, 5.15 per cent; passenger-train cars—new, 2.84 per cent, secondhand, 8.74 per cent; floating equipment—secondhand, 7.78 per cent; work equipment—new, 3.58 per cent, secondhand, 5.43 per cent; miscellaneous equipment—secondhand, 16.22 per cent. Composite percentages (which are not prescribed rates) for all equipment of the Campbell's Creek and the Helena Southwestern, respectively, are 6.22 per cent and 2.7 per cent.

Retirement Board Shifts Personnel

CHANGES in personnel both in Washington, D. C., and in the field were announced by the Railroad Retirement Board on April 17. Edward J. McCormack, who has been chief liaison officer of the Board, has been appointed assistant director of employment and claims, heading the division of clearance and co-ordination, and William A. Rooksbery, who was regional director in Chicago, has been assigned to the position of chief liaison officer of the bureau of employment and claims.

Carlton Hayward, former regional director in Cleveland, Ohio, is now regional director in Chicago, and Patrick F. Murphy, director of field service in the Chicago region, has been named regional director in Cleveland. Earl O. Byrd, manager of the Detroit, Mich., district office, has been appointed director of the Richmond, Va., region. Gerald E. Woodcock, district manager of Peoria, Ill., has been named as head of the Chicago district office.

Davidson Now Assistant Chief Inspector of Locomotives

EDWARD H. DAVIDSON has been appointed by President Roosevelt to be assistant chief inspector of locomotive boilers in the Interstate Commerce Commission's Bureau of Locomotive Inspection. Mr. Davidson, whose nomination went to the Senate for confirmation on April 11, has been a district inspector since 1914. He succeeds John B. Brown, who, at his own request, due to ill health, has been transferred to the Pacific coast as district inspector.

I. C. C. Would Modify Locomotive Inspection Rule 116(b)

RAILROADS have been called upon in an order of the Interstate Commerce Commission, by Commissioner Patterson, to show cause on or before July 1 why Rule 116(b) of the Rules and Instructions for the Inspection and Testing of Steam Locomotives and Tenders and their Appurtenances should not be amended to read as follows:

The front cab doors or windows of road locomotives used in regions where snowstorms are generally encountered shall be provided with what is known as a "clear vision" window, or an appliance that will clean the outside of such doors or windows over sufficient area to provide a clear view of track and signals ahead. If a "clear vision" window is used it shall be not less than 5 inches high located as nearly as possible in line of the engineman's vision and so constructed and fitted that it may be easily opened, closed and fastened in desired position.

The order states that the change appears desirable "for purposes of uniformity and the promotion of safety of employees and travelers . . ." Language in the foregoing, not found in the present rule, includes the reference to "an appliance that will clean the outside of such doors or windows. . . ."

Equipment Purchasing and Modernization Programs

Illinois Central.—The Illinois Central has asked the Interstate Commerce Commission for authority to assume liability for $4,734,000 of 2½ per cent equipment trust certificates, maturing in 18 equal semi-annual installments of $263,000 beginning September 1, 1940, and ending March 1, 1949. The certificates will be used to finance the acquisition of 2,000 box cars which the company purchased in 1938 and 1939 on a lease arrangement. The $4,734,000 issue will represent 87.3 per cent of the total purchase price of the cars which was $5,420,000.

St. Louis Southwestern.—The St. Louis Southwestern has been authorized by the federal district court to purchase two rebuilt cafe-lounge cars from the Texas & New Orleans for $19,000 each, and to purchase a Pullman car from the Pullman Company for $18,500 and convert it into a cafe-lounge car.

Terminal Railroad Association of St. Louis.—Directors of the Terminal-Railroad Association of St. Louis have approved the purchase of 10 Diesel-electric switching locomotives at a cost of $700,000.

Wabash.—The Wabash has been authorized by the district court to spend $65,300 to improve and repair 100 box cars.

Orders and Inquiries for New Equipment Placed Since the Closing of the April Issue

FREIGHT-CAR ORDERS

Road	No. cars	Type of Car	Builder
Canadian National	150	Convertible ballast	Canadian Car & Fdry. Co.
C. M. St. P. & P.	35*	70-ton hoppers	Gen. Amer. Trans. Corp.
C. R. I. & P.	150*	Gondolas	Pullman-Std. Car Mfg. Co.
	60	70-ton hoppers	Gen. Amer. Trans. Corp.
D. & R. G. W.	10	Caboose	Company shops
	100	Stock	
Norfolk Southern	40	Flat	Greenville Steel Car Co.
	12	Caboose	Magor Car Corp.

FREIGHT-CAR INQUIRIES

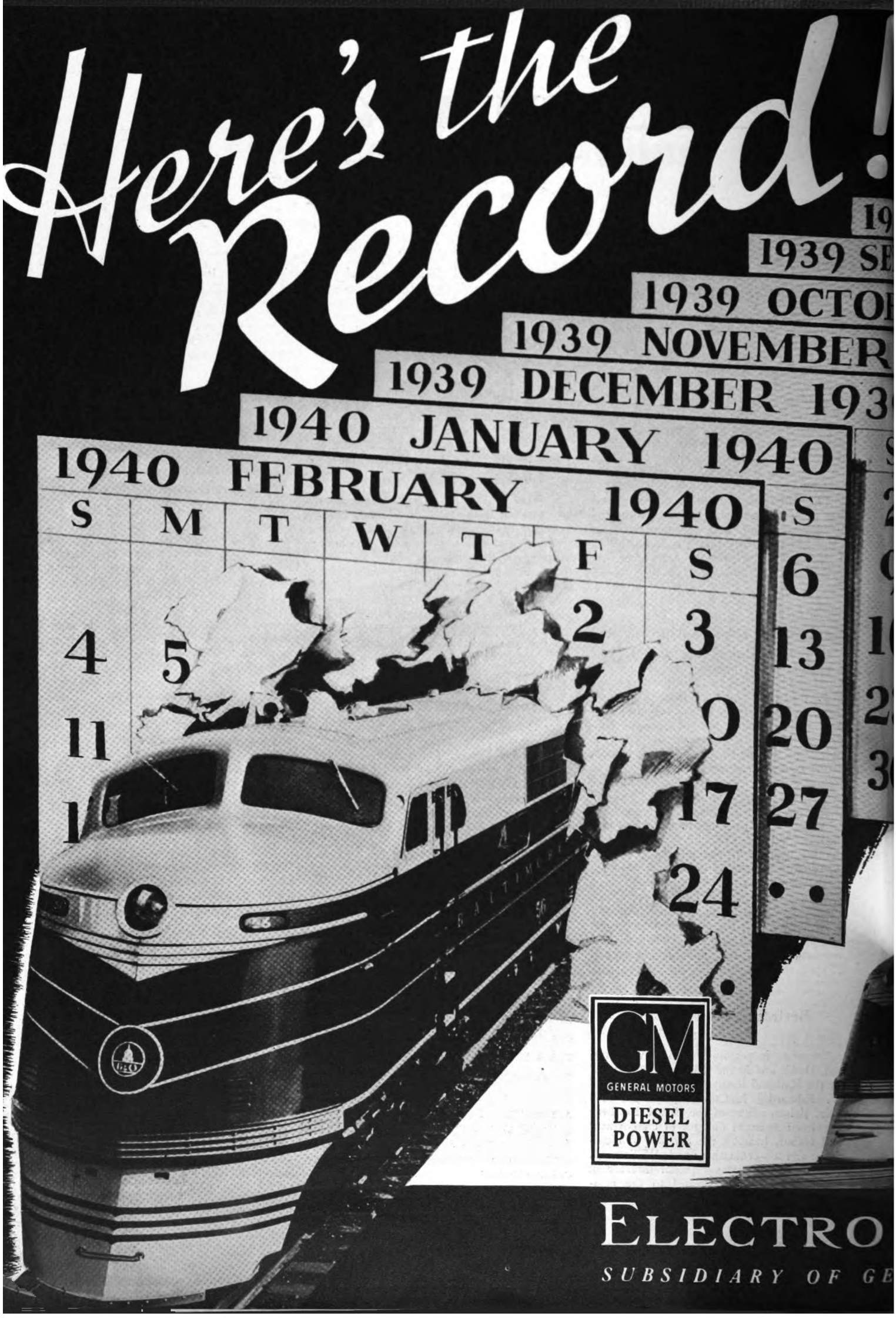
A. T. & S. F.	50	70-ton covered hoppers	.....
C. N. O. & T. P.	75	70-ton covered hoppers	.....
D. & R. G. W.	500	50-ton box	.....

PASSENGER CAR ORDERS

Road	No. cars	Type of Car	Builder
Canadian National	5	Mail-express	Canadian Car & Fdry. Co.
	25	Baggage	

*Lease purchase agreement authorized by federal district court.

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Here's the Record!
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Every Day for 365 Days

Continuous Operation

ON February 27th, Diesel locomotive No. 56, which powers the "Capitol Limited" between Washington, D. C. and Chicago, completed its 365th consecutive run of 771 miles without missing a trip, a total of 281,415 miles...Since being delivered to the Baltimore and Ohio Railroad on June 28, 1938, Diesel locomotive No. 56 had operated 436,718 miles with only three days out of service for repairs — an availability record of 99.6 per cent.

The 100 per cent record of continuous locomotive miles for the past year is a lasting tribute to the Baltimore and Ohio Railroad and is proof of what can be accomplished with this type of motive power.



MOTIVE CORPORATION

ERAL MOTORS LA GRANGE, ILLINOIS, U. S. A.

Supply Trade Notes

JOHN S. MACE, district manager of the United States Metallic Packing Company, Philadelphia, Pa., who entered the employ of this company in 1906, retired on May 1. Mr. Mace continues in an advisory capacity, however.

◆

THE PITTSBURGH PLATE GLASS COMPANY, Pittsburgh, Pa., will construct on a 21-acre tract of land at Houston, Tex., a paint plant consisting of three main buildings, auxiliary units and storage tanks.

◆

GEORGE W. ALCOCK, assistant to the president of the Franklin Railway Supply Company, Inc., since 1936 has become a vice-president. His headquarters will continue to be at New York. Mr. Alcock was in the engineering department of the American Locomotive Company from 1902 until the World War, during which he was special assistant to W. H. Marshall in the Production division of the U. S. Army Ordnance Department. At the close of the war, he entered the sales department of Lima Locomotive Works, Inc., and in 1934 was appointed assistant to the president of that company. In 1939 Mr. Alcock became assistant to the chairman, which position he still holds. Since 1934, he has also been secretary and treasurer of The Locomotive Institute.



George W. Alcock

◆

PULLMAN-STANDARD CAR MANUFACTURING COMPANY.—*Norman B. Johnson,* manager of freight shops of the Pullman-Standard Car Manufacturing Company, Chicago, has also been appointed acting chief engineer to succeed *A. Christianson,* who has asked to be relieved of his duties, but remains in the service of the company as consulting engineer. *M. R. Kempton,* principal engineer, has been promoted to engineer of freight for all plants, with headquarters at Michigan City, Ind.

AIR REDUCTION CO.—*John J. Crowe,* manager of the Apparatus Research and Development department of the Air Reduction Company, New York, has been appointed assistant to *Herman Van Fleet,* vice-president and operating manager. Mr. Crowe will direct the activities of the Apparatus Research and Development department and will co-ordinate these activities with similar activities for Wilson Welder & Metals Co., Inc. In addition, he will handle apparatus, patent matters for Mr. Van Fleet. *H. E. Landis, Jr.,* assistant to Mr. Crowe, has been appointed manager of the Apparatus Research and Development department and *C. G. Andrew* has been appointed manager of gas plants.

◆

DUFF-NORTON MFG. CO.—*Earl E. Thulin,* district manager of Duff-Norton Manufacturing Company at Chicago, has been elected vice-president and general manager of sales. For the present, he will be located at Chicago and later in the year will move to the general offices at Pittsburgh, Pa. *C. N. Thulin,* vice-president at Chicago, will act in a sales executive capacity as a special representative in all territories. *W. I. Floyd,* assistant to the president, at Pittsburgh, has also been appointed assistant general manager of sales, with the same headquarters.



Earl E. Thulin

Earl E. Thulin was born on May 8, 1901, in St. Paul, Minn., and after graduating from Lane Technical High School in Chicago, entered the employ of the sales and service department of the Duff-Norton Manufacturing Company. Later he was promoted to district manager at Chicago.

◆

INTERNATIONAL NICKEL CO., INC.—*F. L. LaQue,* assistant director of technical service on mill products for The International Nickel Company, Inc., in New York, is now engaged in development activities on all applications of both ferrous and nonferrous nickel-containing alloys. Mr. LaQue has been associated with International Nickel since 1927, devoting his activities to the field of corrosion and corrosion-resisting materials. *Dr. William A. Mudge,* works metallurgist of the rolling mill at Huntington, W. Va., who has been with the company since 1920, and who recently joined the technical service section of the Development and Research division in New York, has been appointed assistant director of technical service to succeed Mr. LaQue.

Obituary

ARTHUR G. HOLLINGSHEAD, president of the Viloco Railway Equipment Company, the Okadee Company and the Viloco Machine Company, Chicago, died in University Hospital in that city on April 23.

◆

FRANK A. PURDY, manager of sales of the Vapor Car Heating Company of Canada, Ltd., Montreal, Que., died in that city on March 21, at the age of 74 years. He had been with the company since January, 1916.

◆

L. GERARD SMITH, assistant treasurer of the Vapor Car Heating Company of Canada, Ltd., Montreal, Que., died in that city on March 14, at the age of 68 years. He had been in the employ of the company since May, 1922.

◆

CHARLES J. NASH, retired president of the Universal Draft Gear Attachment Company, died in Chicago on April 9.



Charles J. Nash

Mr. Nash was born in Blue Earth, Minn., in 1865 and was educated at the University of Minnesota. He began his railroad career with the Great Northern, and was later employed by the Diamond Iron Works, the La Fayette Car Works, the Pullman Company, the Standard Steel Car Company, and the Westinghouse Air Brake Company. In 1912 Mr. Nash helped found the Universal Draft Gear Attachment Company, and from that date until his retirement in 1932 was its president.

Personal Mention

General

I. I. SYLVESTER, special engineer of the Canadian National, has been appointed chief inspector of Diesel equipment, with headquarters as before at Montreal, Que.

A. W. THORSON has been appointed assistant fuel service engineer of the Chesapeake & Ohio, with headquarters in the General Motors Building, Detroit, Mich.

HARVEY H. JONES, general locomotive foreman of the Cheyenne shops of the Union Pacific at Cheyenne, Wyo., has been promoted to assistant to the superintendent of motive power and machinery, Western districts, with headquarters at Pocatello, Idaho.

E. R. BUCK, master mechanic on the Pennsylvania at Pitcairn, Pa., has been appointed superintendent of motive power of the Wabash, with headquarters at Decatur, Ill., succeeding George Franklin Hess, who retired on April 18.

GEORGE FRANKLIN HESS, superintendent of motive power of the Wabash at Decatur, Ill., retired on April 18. Mr. Hess was born at Ft. Wayne, Ind., on January



George Franklin Hess

1, 1872, and entered railway service as a messenger boy in the mechanical department of the Pennsylvania in 1886. In March, 1887, he became a machinist apprentice in the Pennsylvania shops at Ft. Wayne, and four years later was appointed a machinist. He later served on the Cleveland & Pittsburgh (now part of the Pennsylvania) at Wellsville, Ohio, the Cleveland, Canton & Southern (now part of the Wheeling & Lake Erie) at Canton, Ohio, the Atchison, Topeka & Santa Fe, at Raton, N. M., the Cleveland, Cincinnati, Chicago & St. Louis (Big Four), at Wabash, Ind., and the Wabash at Ft. Wayne, Ind. In September, 1897, he was promoted to enginehouse foreman at Montpelier, Ohio, and a short time later was transferred to Delray, Mich. In May, 1899, he joined the Grand Trunk Western as general foreman at Detroit, Mich., and later served the Chicago, Rock Island & Pacific as enginehouse foreman at Pratt, Kan., and at Caldwell, Kan. In July, 1902, Mr. Hess was advanced to general foreman of the 47th Street (Chicago) shops, and March, 1903, he went with the Baltimore & Ohio as erecting foreman at Newark, Ohio. One month later, was appointed general foreman at South Chicago, and in June, 1903, was promoted to the position of master mechanic at Lorain, Ohio. In November, 1910, he was transferred to Chillicothe, Ohio, and on August 1, 1911, was appointed superintendent of machinery of the Kansas City Southern, with headquarters at Pittsburg, Kan. Mr. Hess was appointed superintendent of motive power of the Wabash, with headquarters at Decatur, Ill., on June 1, 1920, holding that position until his retirement.

Master Mechanics and Road Foreman

C. E. FARLEY, who has been appointed master mechanic of the Chicago, Rock Island & Pacific at Des Moines, Iowa, as noted in the April issue, was born on September 18, 1881, at Brockfield, Mo. He attended public school at Trenton, Mo., and in 1899 became a machinist apprentice on the Rock Island. During 1903, 1904 and 1905 he served on various railroads—the Illinois Central, the Missouri Pacific, the Wabash, the Cleveland, Cincinnati, Chicago & St. Louis, and the Chicago & Eastern Illinois—as a machinist. He returned to the Rock Island at Horton, Kan., in 1905, being promoted to the position of erecting foreman on September 1, 1910. He became general foreman at Goodland, Kan., in March, 1915; general foreman at Cedar Rapids, Iowa, in June, 1917, and general foreman at Horton, in April, 1919. He was appointed master mechanic at Silvis, Ill., on March 1, 1937, and was transferred to Des Moines in February, 1940.

C. S. HOGAN, who has been appointed master mechanic of the McCloud River Railroad at McCloud, Calif., as noted in the April issue, was born on June 20, 1895, at San Francisco, Calif. His grade school education was followed by extension courses. On September 1, 1910, he became a messenger boy in the freight department of the Southern Pacific. In May, 1911, he entered the mechanical department as a messenger, subsequently becoming a machinist apprentice. In December, 1917, he enlisted as a machinist mate in the United States Navy. He returned to the Southern Pacific in March, 1919, and until February, 1926, was machinist lead valve man and extra foreman. In the latter year he became assistant master mechanic of the McCloud River Railroad, and in February, 1940, was appointed master mechanic.

Car Department

T. J. PAYNE, car foreman on the Canadian Pacific at Outremont, Que., has retired.

JOSEPH V. PASEWICK has been appointed assistant general car foreman of the New York, Chicago & St. Louis, with headquarters at Chicago.

Shop and Enginehouse

J. A. SPEIR, night enginehouse foreman of the Chesapeake & Ohio at Huntington, W. Va., has been promoted to the position of day enginehouse foreman at Huntington.

R. A. PYNE, Jr., shop foreman of the Canadian Pacific at Kenora, Ont., has become locomotive foreman with the same headquarters.

H. J. CANTRELL, foreman on the Chesapeake & Ohio at Huntington, W. Va., has been promoted to the position of night enginehouse foreman at Huntington.

E. J. SANDERS, enginehouse foreman of the Chesapeake & Ohio at Huntington, W. Va., has been appointed general foreman, with headquarters at Fulton, Va.

JOSEPH D. FARLEY, assistant to supervisor of lubrication and supplies of the Chesapeake & Ohio at Richmond, Va., has been appointed assistant enginehouse foreman, Fulton shops.

Purchasing and Stores

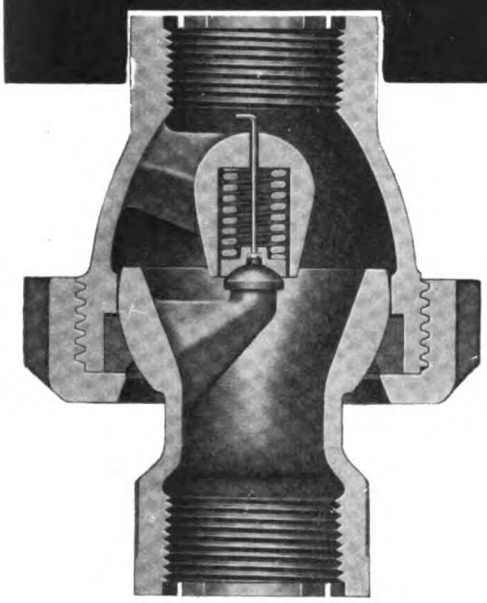
J. L. SULLIVAN, storekeeper on the Union Pacific at the Omaha (Neb.) general store, has been promoted to assistant general storekeeper at Omaha.

H. M. SMITH, general storekeeper on the Northern Pacific at Saint Paul, Minn., retired on April 1 after 41 years of service. Mr. Smith was born at Dover, Minn., on July 11, 1873, and entered railway service on December 13, 1899, as a stores attendant in the St. Paul shops of the Northern Pacific. He advanced through various positions in the stores department until 1921, when he was appointed traveling storekeeper. Five years later, Mr. Smith was promoted to the position of assistant general storekeeper at St. Paul, and on August 1, 1932, became general storekeeper.

Obituary

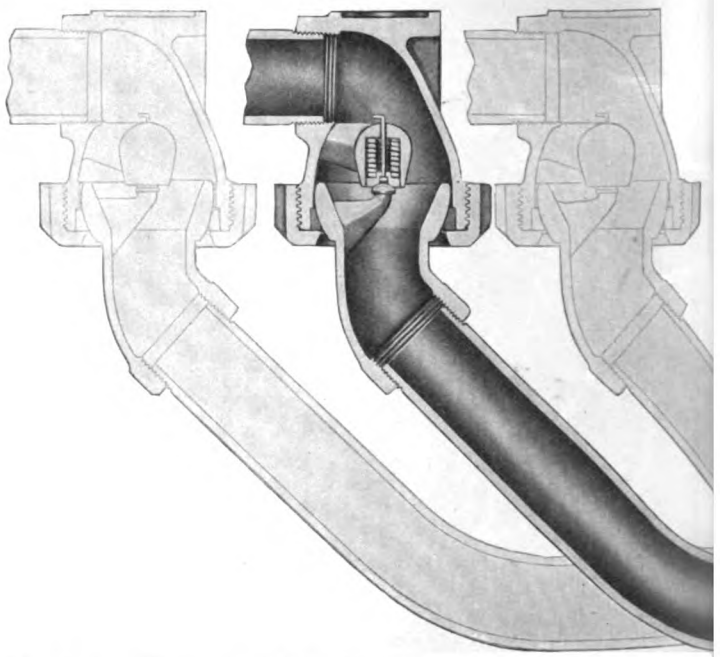
M. F. BROWN, fuel supervisor of the Northern Pacific, with headquarters at St. Paul, Minn., died suddenly of a heart attack on April 13.

Announcing THE NEW



THE BARCO Type X streamlined flexible ball joint incorporates important and entirely new features of design resulting in longer life with freedom from leakage of fluids or air. It has automatic adjustment to compensate for wear, expansion and contraction encountered with varying or fluctuating pressures and temperatures.

33-1/3% more flexibility—Automatic adjustment—Uniform contact between the ball and gasket in all positions—Number of gaskets reduced 50%—Heavy square threads between nut and casing—High volume efficiency.





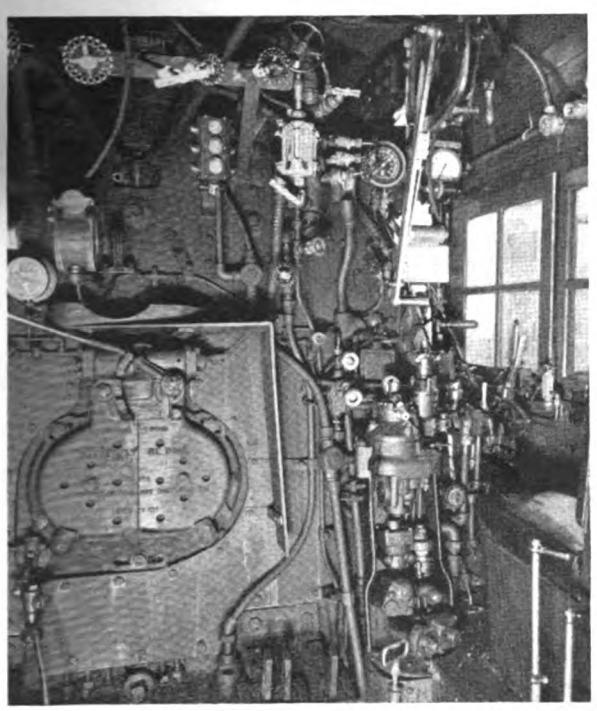
These latest 4-8-4 freight locomotives are equipped with BARCO type 3VX connections and BARCO type M-13RB reverse gears.

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RAILWAY MECHANICAL ENGINEER

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With which are also incorporated the National ***Car Builder, American Engineer and Railroad Journal,*** *and Railway Master Mechanic.* ***Name Registered, U. S. Patent Office.***



See page 216

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June, 1940

Volume 114 *No. 6*

Car:

Overhead Icing in C. N. Refrigerator Cars 211
Problems of Freight-Car Weight Reduction 223

Locomotive:

Milwaukee Buys More 4-8-4 Freight Power 216
Quenched and Tempered Locomotive Forgings 219

Editorials:

Availability of Steam Locomotives 225
The Value of Modern Equipment Is Now Evident 225
How to Increase Freight Train Speeds 226
New Books 227

Backshop and Enginehouse:

Paducah Shop Jigs, Fixtures and Devices 228
Failures of Diesel Engine Parts 232
Boiler Patch Formed to Fit Offset Between Two Courses 232
Locomotive Boiler Questions and Answers 233
Double-Spindle Threading Machine 233

Car Foremen and Inspectors:

Forming Steel Car Parts 234
Air Screen Protects Rivet Heater 235
Arbitration Decisions 235
Bethlehem Develops High-Carbon Tool Steel 236
Welding Positioner 237
Effective One-Piece Self-Locking Nut 237

The Reader's Page:

Diesel Versus Steam 238
Unit Pressures Allowable on Oil-Lubricated Bearings ... 238
Preventing Boiler Explosions Due to Low Water 238

High Spots in Railway Affairs 239

Clubs and Associations 240

News 241

Index to Advertisers ..... (Adv. Sec.) 54

Two more new trains EQUIPPED WITH "D-R" V-Belt Axle Drives



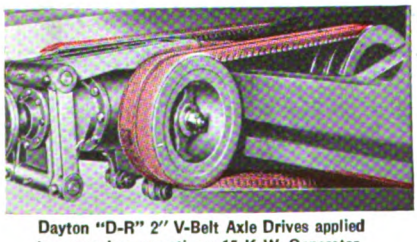
New trains like the Missouri Pacific "Eagle" and the Burlington "Silver Streak Zephyr" are making headlines as outstanding examples of deluxe transportation. And, included in their modern equipment, you will find Dayton V-Belt Drives.

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THE DAYTON RUBBER MFG. CO.
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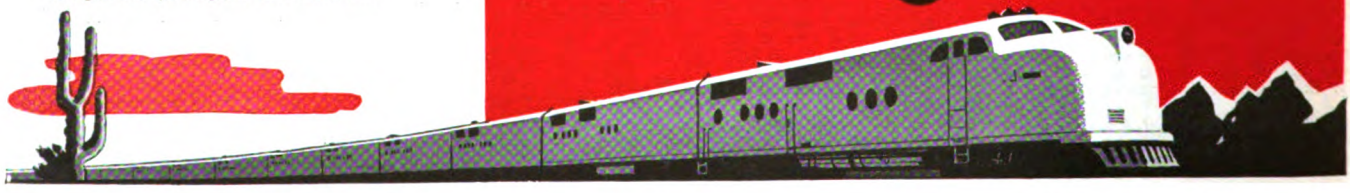
Dayton "D-R" 2" V-Belt Axle Drives applied to a gear box operating a 15 K.W. Generator.

Dayton

"D-R" V-BELT AXLE DRIVES AND ENDLESS COG-BELT DRIVES

FOR CAR-LIGHTING AND AIR-CONDITIONING EQUIPMENT

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Overhead Icing in

C. N. Refrigerator Cars

Cars built by railroad have a steel superstructure with eight overhead ice tanks and are equipped with underslung heater and device indicating inside temperatures — Tests demonstrate desirable characteristics of these cars

For several years the Canadian National has been experimenting with refrigerator cars having overhead ice tanks. After building and testing various designs of refrigerator cars of this type, it was decided that cars with continuous baffles or drip pans under the tanks which connect up with side flues and having tanks that retain half the meltage were the most desirable.

As a result of this experimental work, the Canadian National has built 100 refrigerator cars with overhead ice tanks at its Transcona, Manitoba, shops, the first of which was completed in October, 1939. These cars have eight overhead tanks with a total capacity of 6,500 lb. of crushed ice, continuous baffles, and metal side flues through which the meltage and cold air descends. They have a steel superstructure with an inside wood lining, metal sub-floors and a metal inside floor, cadmium plated. They are equipped with underslung charcoal heaters having manually operated draft controls. The temperatures inside the car at the top and bottom of the doorway are indicated by Liquidometers, the dials of which are mounted on the outside of the car near the doorway, making it possible to check the inside temperatures enroute.

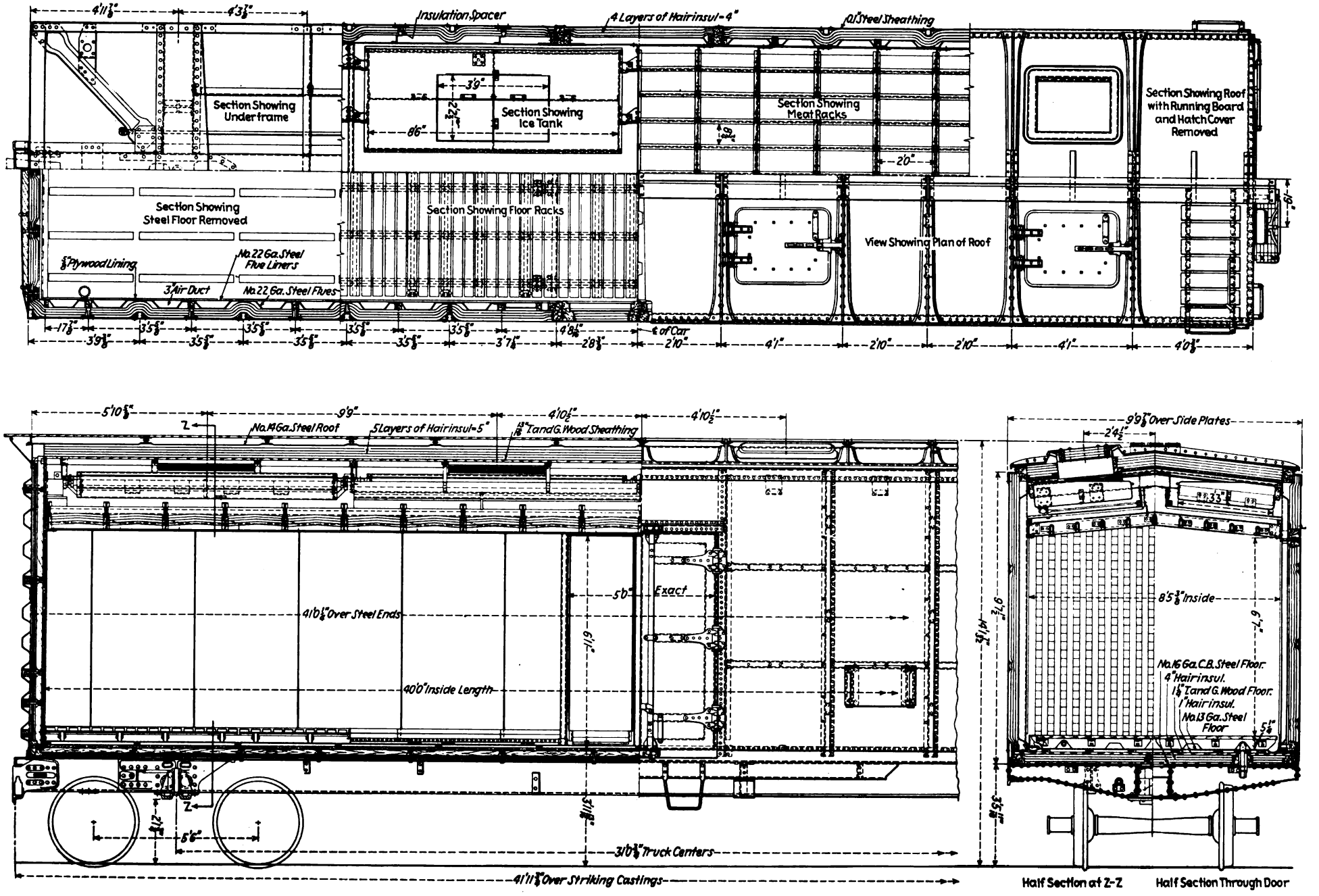
The cars are equipped with underframes of A. A. R. design and Barber stabilized trucks having Dalman cast-steel side frames. They have an inside length of 40 ft., an inside width of 8 ft. 5⅜ in. and an inside height between the top of the floor racks and the bottom of the meat racks of 6 ft. 7 in. The cars have a weight capacity of 65,000 lb., a cubic capacity of 2,216 cu. ft. and a light weight of 70,200 lb.

The Superstructure

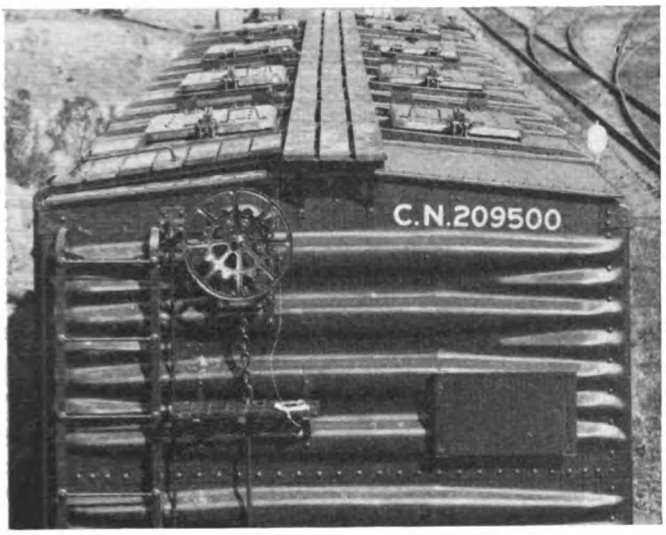
The superstructure is of steel instead of wood as commonly employed in refrigerator cars. The side posts are special pressings, 2½ in. by 2⅜ in., and the Z-section side plates are 4⅜ in. by 3⅜ in. by 2½ in. A W-section



The Canadian National refrigerator cars have a steel super-structure—The dials indicating inside temperatures may be seen mounted near the doorway



Elevation and cross-sections of the Canadian National refrigerator cars with overhead ice tanks



The roof arrangement with four hatches on each side of the running board

corner-post construction is used and Dreadnaught steel ends have been applied. The outside sheathing is of .10-in. plate with the plate offset at the lapped joints which are made water tight by the application of a layer of asbestos felt. Copper-bearing steel is used for plates and pressings under ½ in. in thickness. The cars are equipped with the Murphy all-steel riveted type roof with which are combined the hatch frames.

The inside steel framing consists of an inside side sill of 3-in. by 3-in. by ¼-in. angles, an inside side plate, 8 in. by $^{3}/_{16}$ in., and Z-section side posts, $1^{3}/_{16}$ in. by 3 in. by $2^{3}/_{16}$ in., to which are bolted 2⅞-in. by 2½-in. sub side posts of fir. The ceiling carlines are 2½-in. U-shaped pressings of ⅛-in. steel to which are bolted 2¼-in. by 1½-in. furrings. A wood ceiling of $^{13}/_{16}$-in. by 3¼-in. fir is applied longitudinally, nailed to the carline furrings. The hatch frames are of $^{5}/_{32}$-in. pressed steel and are welded to the roof sheets and to the hatch carlines. The combination hatch covers and plugs are built up of wood and steel and are equipped with Equipco hatch closure fittings. The edge seal consists of hair insulation covered with canvas while the top seal is made of sponge rubber cemented to the hatch frame.

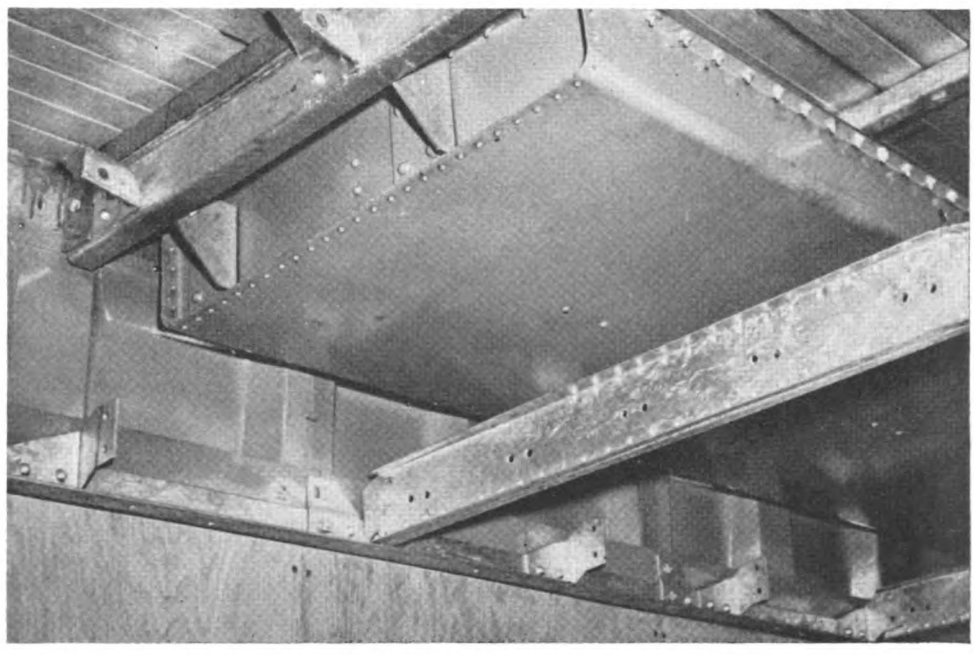
The ice tanks are suspended below the ceiling by pressed brackets riveted to channel-shaped pressings of ⅛-in. open-hearth steel, 5 in. deep, running crosswise of the car. The tanks have an inside length of 8 ft. 6 in., an inside width of 3 ft. 3 in. and are made in two pieces of No. 13 gage open-hearth steel bolted together by $^{5}/_{16}$-in. cadmium-plated bolts. There are six 1-in. drain holes on the inside vertical wall of the tanks and a special brass valve at the bottom to permit the drainage of the brine from the tanks. A galvanized wire netting is applied between the top of the tank and the under side of the hatch frame.

The continuous baffles or drain pans under the tanks are built up of No. 22 gage open-hearth steel, wood furrings, and five-ply ⅝-in. plywood panels. They are supported at the center of the car by brackets fastened to the ceiling carlines and to the tank-support channels and at the sides of the car by brackets fastened to the meat-rack supporting angles. A removable pan is installed under the brine drain valve on the outside edge of each tank. Both the ice tanks and the drain pans have a Promat finish which is a flexible vitreous enamel baked on to the steel, giving to them a porcelain-like rustproof surface. Underneath the drain pans are nine white oak meat racks running the length of the car which are supported by 19 meat rack carriers made of ⅛-in. channels.

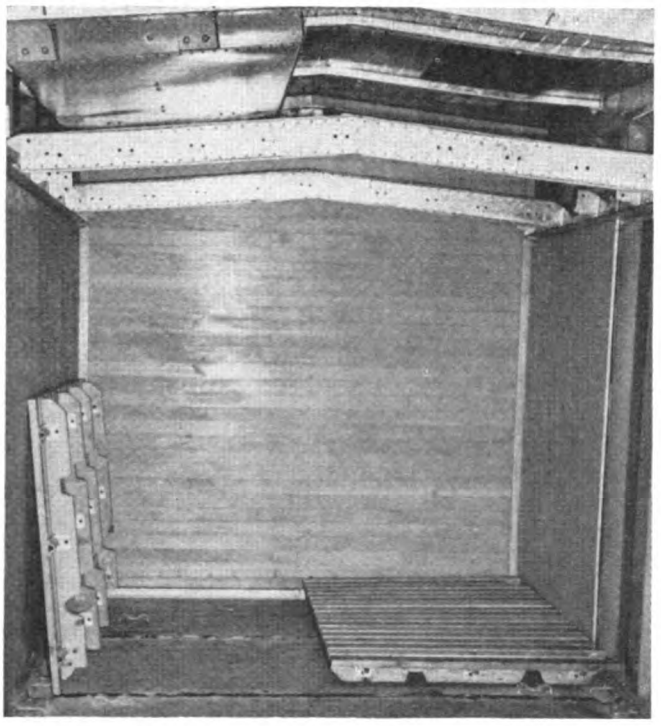
The air ducts through which the cold air circulates downward at the sides of the cars consist of steel pans and covers of No. 22 gage open-hearth steel with a Promat finish. The ducts are fastened to the steel floor and inside side plates by stainless steel screws and to the inside wood posts by cadmium-plated wood screws.

Principal Dimensions and Data on the Canadian National Refrigerator Cars with Overhead Ice Tanks

Length over strikers, ft.-in.	41—11¼
Length inside, ft.-in.	40— 0
Length, center to center of trucks, ft.-in.	31— ¾
Width over side plates, ft.-in.	9— 9⅞
Width, inside, ft.-in.	8— 5⅜
Height, inside, ft.-in.	6— 7
Height, rail to top of running board, ft.-in.	14— $^{17}/_{32}$
Ice capacity, lb.	6,500
Capacity, cu. ft.	2,216
Capacity, lb.	65,000
Light weight, lb.	70,200



The ice tanks are supported by channels running cross-wise of the car—The metal air ducts through which the meltage and cold air descend are in place along the side of the car



One of the hinged floor racks is raised to show the cadmium-plated metal floor laid in sections with a waterproof compound in the seams

Over the duct covers is a 5/8-in. plywood lining with the panels extending from the top of the floor rack to the under side of the meat-rack supporting angles and from center to center of the inside wood posts to which they are fastened by galvanized wood screws.

A deafening floor of No. 16 gage copper-bearing steel is riveted to the underframe. Above the deafening floor is a wood floor supported by sub side sills of 6-in. by $3\frac{5}{16}$-in. fir and by a 2-in. by 4-in. wood stringer at the center.

A departure from the usual construction of refrigerator car floors is the application of a steel floor, cadmium plated, over the wood floor. It is of 1/8-in. steel made in sections bolted together with the seams filled with a water-proof compound. The outside edges of the sections are shaped to form a continuous gutter at each side of the car connecting up with drain traps at the corners. This floor is held to the inside side sill by brackets but is not fastened to the six $1\frac{1}{8}$-in. by 3-in. wood stringers running the full length of the car which support the floor between the sides.

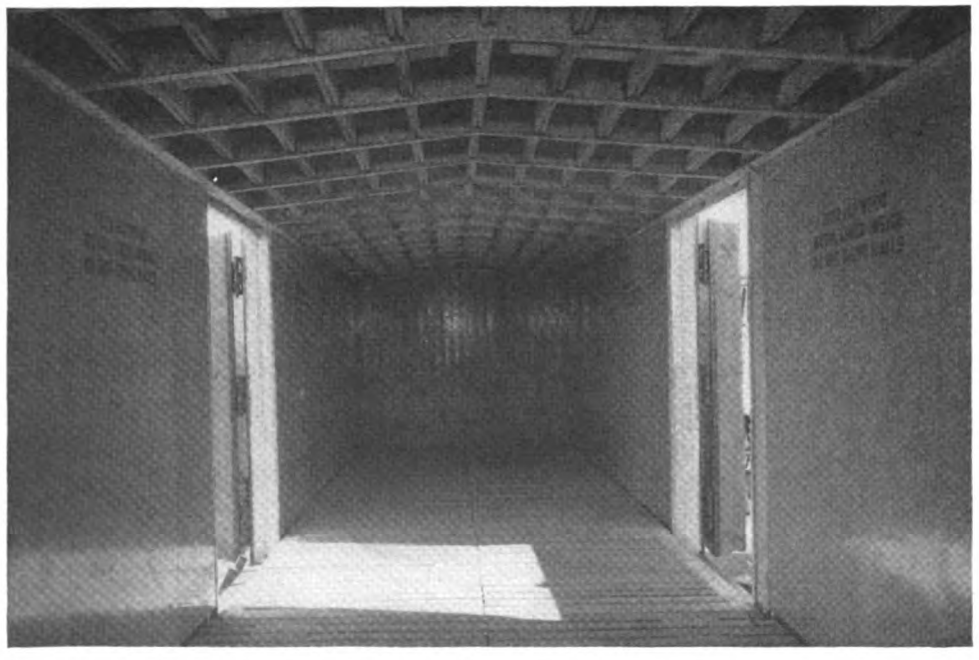
The cars are equipped with hinged floor racks, the supports for the hinges and the heater coils being welded to the steel floor. The side doors have a steel frame with outside sheeting of 0.10-in. copper-bearing steel pressed to shape, and are hung by three self-locking hinges. The doors are equipped with ducts and lining similar to that applied to the body of the car.

Insulation

The cars are insulated by layers of Hairinsul in the sides, floors, and roofs. To the inside of the sheathing is applied four layers of 1-in. insulation, each layer extending from side sill to side plate and from door post

Partial List of Materia's and Equipment on the Canadian National Refrigerator Cars with Overhead Ice Tanks

Truck, stabilized	Consolidated Equipment Co.
Truck frame and bolster	International Equipment Co.
Journal box lids	Holden Co., Ltd.
Dust Guards	International Equipment Co.
Draft gear	Canadian Appliance Co.
Coupler centering device	Standard Railway Equipment Mfg. Co.
Couplers, coupler yokes	Canadian Steel Foundries Dominion Foundry & Steel
Air brake equipment	Canadian Westinghouse Co.
Brake hangers, brake lever connections	International Equipment Co.
Brake mast platform	Consolidated Equipment Co.
Brake beam supports	Buffalo Brake Beam Co.
Hand brake	Holden Co., Ltd.
Roof, hatches	Standard Railway Equipment Mfg. Co.
Hatch closure	Consolidated Equipment Co.
Hatch seal	Dunlop Rubber Company, Ltd.
Steel ends	Standard Railway Equipment Mfg. Co.
Insulation supports and spacers	Canadian Appliance Co.
Insulation, roof, sides, and floors	American Hair and Felt Co.
Door frame	Consolidated Equipment Co.
Door fasteners	W. H. Miner, Inc.
Door hinges	Union Railway Equipment Co.
Door insulation	Canadian Appliance Co.
Floor, steel; floor rack hinges; floor rack supports	Consolidated Equipment Co.
Threshold plates; insulation	Johns-Manville Co., Ltd.
Defect card holders	Holden Co., Ltd.
Heaters	The Robert Mitchell Co., Ltd.
Tanks, ice; drip pan; ducts	Standard Railway Equipment Mfg. Co.
Drain traps	Union Railway Equipment Co.
Temperature recorders	W. K. Davidson Co.
Drain valve	Crane Co.
Sylvaply fir panels	H. R. MacMillan Export, Ltd.
Phemaloid	Railway Power & Engineering Corp.
Promat finish	Holden Co., Ltd.



The finished interior—Plywood is used for the inside lining of the side walls—The inside height between the top of the floor racks and the bottom of the meat racks is 6 ft. 7 in.

Comparison of Temperatures in an Experimental Canadian National Overhead Ice Car and a Conventional End-Bunker Car, Both Loaded with Bananas, New Orleans, La. to Omaha, Neb.

Station	Time	Date, 1939	Outside temp., deg. F.	Average temp., deg. F. Top	Average temp., deg. F. Bottom	Temp. Spread, deg. F.	Max. Temp. deg. F.	Min. Temp. deg. F.	Temp. Spread deg. F.
			Canadian National 207902						
New Orleans, La. (after loading)	11:45 a.m.	Aug. 25	87	79.20	78.6	.60	80	77.5	2.5
New Orleans, La. (at ice house)	2:40 p.m.	Aug. 25	91	78.75	78.0	.75	79.5	77.0	2.5
McComb, Miss.	7:35 p.m.	Aug. 25	80	74.80	73.0	1.80	76.7	69.7	7.0
Jackson, Miss.	10:00 p.m.	Aug. 25	75	72.30	70.4	1.90	75.0	67.5	7.5
Memphis, Tenn.	8:45 a.m.	Aug. 26	85	63.90	59.4	4.50	67.2	56.0	11.2
Fulton, Ky.	2:30 p.m.	Aug. 26	94	60.40	55.5	4.90	63.3	52.8	10.5
Bluford, Ill.	9:15 p.m.	Aug. 26	68	58.40	55.1	3.30	60.2	53.0	7.2
Effingham, Ill.	1:05 a.m.	Aug. 27	62	57.30	55.0	2.30	59.2	52.0	7.0
Champaign, Ill.	3:40 a.m.	Aug. 27	56	56.60	54.9	1.70	58.3	51.0	7.2
Chicago	8:30 a.m.	Aug. 27	77	55.90	54.7	1.20	57.3	50.8	6.5
Hart, Ill.	1:30 p.m.	Aug. 27	80	56.30	54.8	1.50	57.3	52.0	5.3
Freeport, Ill.	2:40 p.m.	Aug. 27	88	56.40	54.9	1.50	57.5	52.2	5.3
Dubuque, Ia.	8:00 p.m.	Aug. 27	68	57.60	55.6	2.00	58.5	53.7	4.8
Fort Dodge, Ia.	3:40 a.m.	Aug. 28	59	59.40	57.4	2.00	60.0	56.0	4.0
Omaha, Neb.	9:00 a.m.	Aug. 28	76	59.80	58.4	1.40	60.2	57.0	3.2
			Illinois Central 50286						
New Orleans, La. (after loading)	11:50 a.m.	Aug. 25	87	79.80	78.2	1.60	81.5	77.0	4.5
New Orleans, La. (before icing)	2:40 p.m.	Aug. 25	91	80.30	78.2	2.10	81.5	77.5	4.0
McComb, Miss.	7:35 p.m.	Aug. 25	80	75.90	64.2	11.70	76.7	58.5	18.2
Jackson, Miss.	10:00 p.m.	Aug. 25	75	73.30	58.1	15.20	74.7	54.0	20.7
Memphis, Tenn.	8:45 a.m.	Aug. 26	85	62.20	47.8	14.40	64.0	47.5	16.5
Dyersburg, Tenn.	1:15 p.m.	Aug. 26	94	60.70	46.6	14.10	62.2	44.2	18.0
Fulton, Ky.	2:30 p.m.	Aug. 26	94	60.30	46.5	13.80	61.5	44.0	17.5
Bluford, Ill.	9:15 p.m.	Aug. 26	68	58.60	46.6	12.00	59.8	45.0	14.8
Effingham, Ill.	1:00 a.m.	Aug. 27	62	57.20	47.8	9.40	58.8	45.5	13.3
Champaign, Ill.	3:40 a.m.	Aug. 27	56	55.90	48.7	7.20	57.1	46.5	10.6
Chicago	8:30 a.m.	Aug. 27	77	55.90	49.1	6.80	57.2	48.0	9.2
Hart, Ill.	1:30 p.m.	Aug. 27	80	57.80	50.0	7.80	59.0	48.8	10.2
Freeport, Ill.	2:40 p.m.	Aug. 27	88	58.90	50.2	8.70	60.7	49.0	11.7
Dubuque, Ia.	8:00 p.m.	Aug. 27	68	61.50	50.9	10.60	63.3	49.8	13.5
Fort Dodge, Ia.	3:40 a.m.	Aug. 28	59	61.00	52.5	8.50	62.5	52.0	10.5
Omaha, Neb.	9:00 a.m.	Aug. 28	76	60.80	53.5	7.30	62.0	53.0	9.0

around the ends of the car to the opposite door post in one continuous piece. The insulation is held in position by special holders which do not compress it at any point which would decrease its efficiency. The wood ceiling is covered with five layers of 1-in. insulation, each layer running from side plate to side plate for the length of the car with eight openings cut out for the hatch frames. Under the wood floor are four layers of this insulation, each layer in one piece and covering the full length and width of the car. The spaces between the wood stringers supporting the steel floor are also filled with one layer of Hairinsul.

Four layers of insulation are applied to the hatch covers and to the side doors, each layer being in one piece. The door plates are made of a special non-conductive material.

Icing and Temperature Record of Canadian National Overhead Ice Car 209509 with Shipment of Frozen Fish, Prince Rupert, B. C. to Chicago

Station	Time	Date, 1939	Liquidometer Temp., deg. F. Top	Liquidometer Temp., deg. F. Bottom	Outside Temp., deg. F.	Ice and Salt Supplied, lb. Ice	Ice and Salt Supplied, lb. Salt
Prince Rupert	.....	Dec. 7	..	..	..	6,000	1,500
Prince Rupert	.....	Dec. 8	..	..	..	2,400	600
Prince Rupert	6:00 p.m.	Dec. 8	20	14	40	....	....
Pacific	1:15 a.m.	Dec. 9	9	10	38	....	....
Smithers	7:25 a.m.	Dec. 9	8	8	30	....	....
Endako	1:10 p.m.	Dec. 9	6	8	38	....	....
Pr. George	6:00 p.m.	Dec. 9	6	6	35	....	....
McBride	.....	Dec. 10	6	6	38	....	....
Jasper	8:30 a.m.	Dec. 10	6	6	32	....	....
Edson	2:45 p.m.	Dec. 10	6	6	32	....	....
Calder	9:30 p.m.	Dec. 10	6	6	29	....	....
Wainwright	6:45 a.m.	Dec. 11	6	6	30	....	....
Nutana	5:00 p.m.	Dec. 11	6	8	32	....	....
Melville	7:30 a.m.	Dec. 12	6	7	20	....	....
Rivers	12:45 p.m.	Dec. 12	6	6	20	....	....
Winnipeg	9:00 p.m.	Dec. 12	6	6	4	....	....
Rainy River	.....	Dec. 13	4	5	2	....	....
Ft. Frances	2:15 p.m.	Dec. 13	2	2	18	....	....
Duluth	11:30 a.m.	Dec. 14	2	2	30	....	....
St. Paul	6:05 a.m.	Dec. 15	2	2	29	....	....
Milwaukee	.....	Dec. 15	8	6	44	....	....
Bensonville	1:35 a.m.	Dec. 16	9	6	37	....	....
Chicago	7:30 a.m.	Dec. 16	9	6	38	....	....

Tests

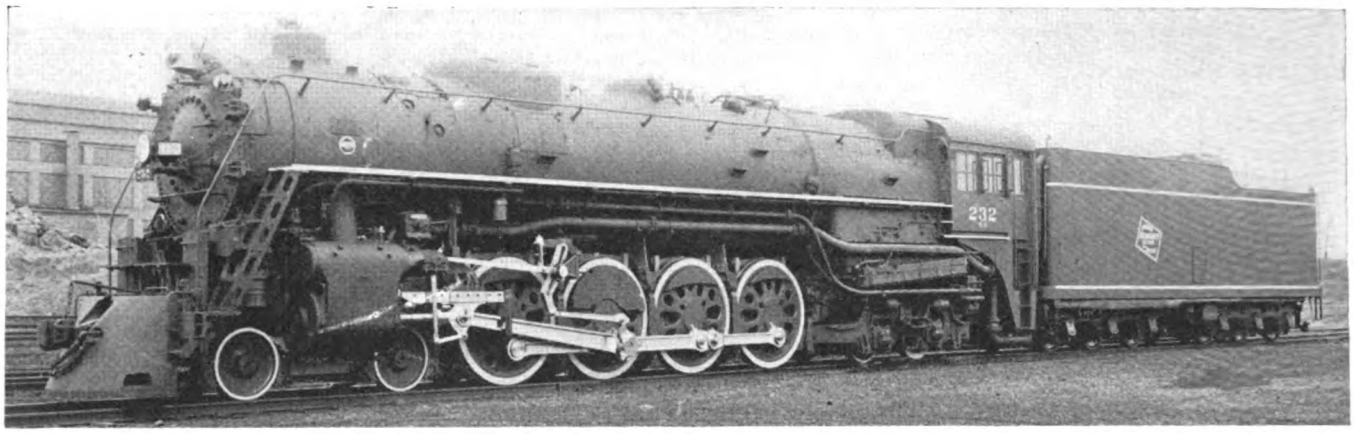
The tests conducted by the Canadian National have demonstrated that these cars possess advantages over the conventional refrigerator car with end bunkers. A great reduction in temperature gradient between the top and bottom of the lading is obtained making it possible to load perishable commodities to the ceiling, particularly those products shipped in a frozen condition. The elimination of end bunkers and doorway bracing, together with the ability to load the cars to the ceiling, permits the cars to be loaded more heavily. The ice in the tanks is effective to the last pound and as the meltage passes down the side flues it absorbs considerable heat before leaving the car, thus reducing the refrigeration costs.

Although the test runs so far for which data are available have of necessity been made during the colder seasons, they do include runs made with shipments of oranges from Florida and California to New York, bananas from New Orleans, La., to Omaha, Neb., and shipments of frozen fish from Canada to destinations in the northern part of the United States.

A test run was made with one of these cars loaded with 840 boxes of oranges weighing 65,520 lb., as compared with a standard end-bunker car load of 462 boxes weighing 34,036 lb., from Bryn Mawr, Cal., to New York. The oranges were at a temperature of 62 deg. F. when loaded and were delivered at New York at a temperature of 45 deg. F. requiring only 12,200 lb. of ice for the entire trip. In another test run made with a shipment of oranges from Auburndale, Fla., to New York, the car carried a load of 65,000 lb. as compared with a standard load of 36,000 lb. On this run the load was cooled an average of 27 deg. F. in about 71 hr.

In an accompanying table is shown the icing and

(*Continued on page 218*)



Milwaukee Buys

More 4-8-4 Freight Power

Ten locomotives recently delivered by Baldwin alike in general proportions to those purchased from the same builder two years ago

AN order of ten 4-8-4 type locomotives has recently been delivered to the Chicago, Milwaukee, St. Paul & Pacific by the Baldwin Locomotive Works. These locomotives are similar in dimensions and in general features of construction to the thirty locomotives of the same type delivered by Baldwin to this railroad early in 1938.* They are designed for freight service and develop a tractive force of 70,800 lb. The driving wheels are 74 in. in diameter and the cylinders 26 in. by 32 in. The boilers carry a working pressure of 285 lb. per sq. in. They have an evaporative heating surface of 5,467 sq. ft. and a superheating surface of 2,336 sq. ft. The grate area is 106 sq. ft.

The new locomotives differ in some detail and in weights from the earlier order. The total weight of the engine has been increased 3,100 lb. By redistribution of the weight, the weight on drivers has been increasd about 6,800 lb. There is practically no difference in the combined weight of engine and tender.

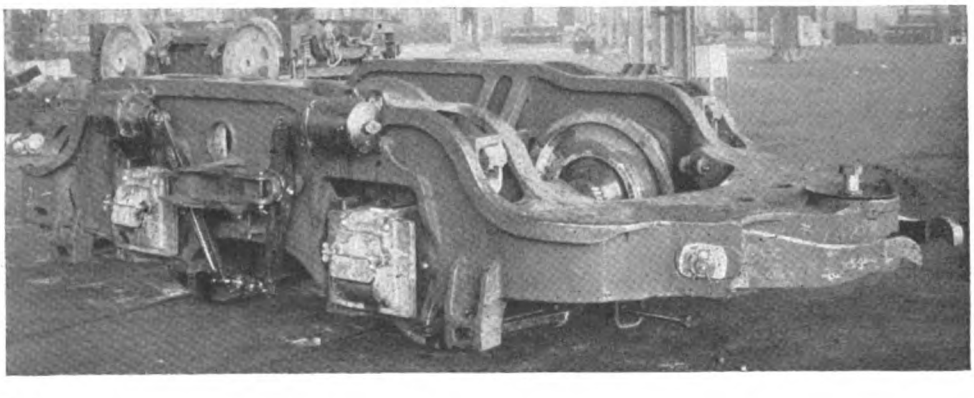
The boilers are of the conical-connection type with roof, side and wrapper sheets of silico manganese steel. The joints of all the sheets in the firebox and combustion chamber are butt welded, and an unusual amount of seal welding has been done on the wrapper and throat sheets and on the barrel seams.

Each firebox is fitted with five American Arch circulators and one is installed in the combustion chamber. The locomotives are fired by a modified type B du Pont stoker and have Firebar grates with 20 per cent air openings.

The locomotives have the Wilson feedwater heater, the hot well of which is located about half way back in the tender tank. The boiler equipment also includes the Barco low-water alarm and Wilson sludge remover. In the front end is the Anderson spark arrester.

The foundation of these engines is the Commonwealth bed casting with integral cylinders and back cylinder heads. The driving wheels are Boxpok cast-steel centers, and the journals run in Timken roller bearings. There is an Alco lateral motion device on the front pair. The engine trucks have Timken inside roller-bearing journal boxes and both trailer axles are fitted with American Steel Foundries roller-bearing units.

* See the *Railway Mechanical Engineer* for April, 1938, page 123.



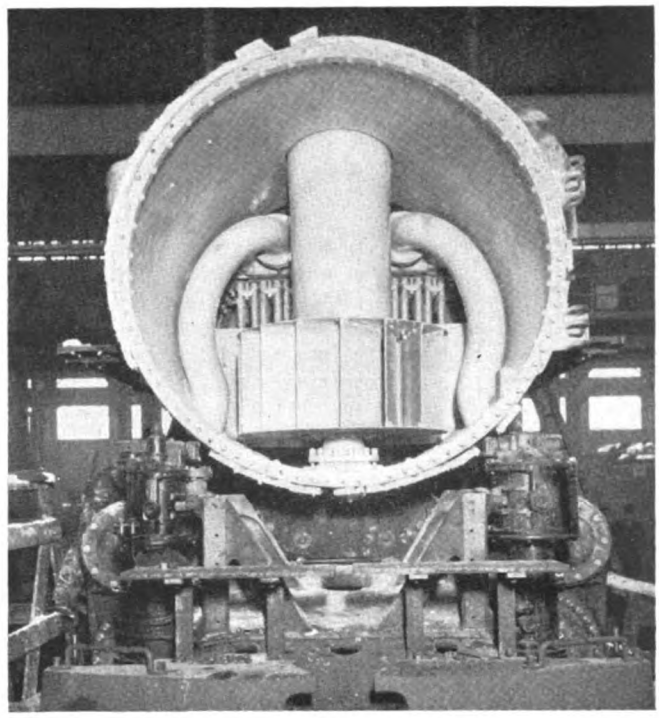
The Commonwealth trailing truck is fitted with A. S. F. roller-bearing units

The main and side rods are fitted with floating bushings on all crank pins, with fixed bushings of Hunt-Spiller gun iron in the rods. The cylinder and valve-chamber bushings are also of this material, and the pistons have Hunt-Spiller valve bull rings with combination bronze and iron Duplex sectional packing.

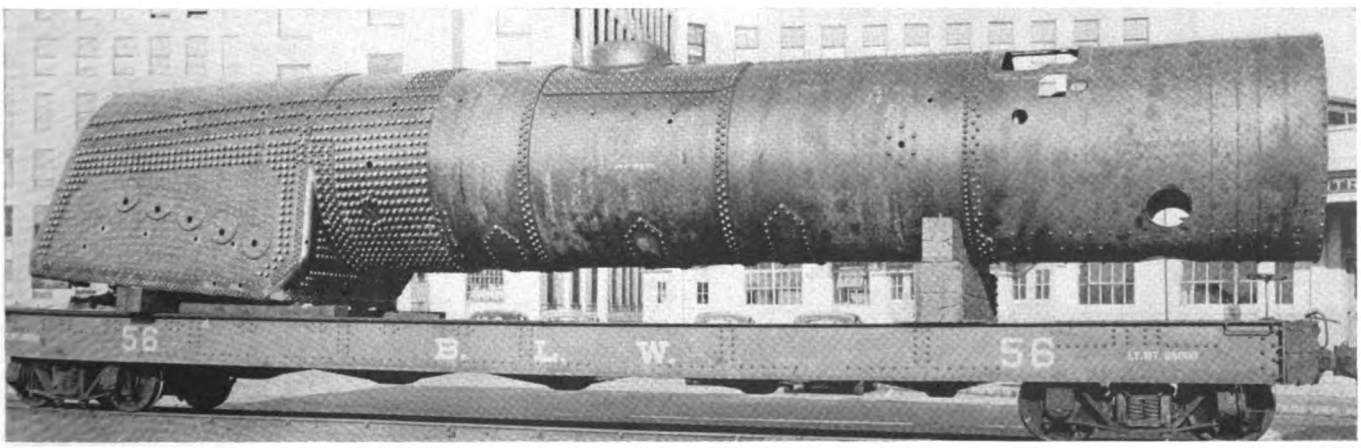
The Walschaert valve motion provides a valve travel

General Dimensions, Weights and Proportions of the C. M. St. P. & P. 4-8-4 Type Locomotives

Railroad	C. M. St. P. & P.
Builder	Baldwin
Type of locomotive	4-8-4
Road class	S-2
Road numbers	231 to 240
Date built	1940
Service	Freight
Dimensions:	
Height to top of stack, ft.-in.	16- 0
Height to center of boiler, ft.-in.	10- 8
Width overall, in.	130½
Cylinder centers, in.	92½
Weights in working order, lb.:	
On drivers	289,147
On front truck	84,963
On trailing truck	119,440
Total engine	493,550
Tender	394,300
Wheel bases, ft.-in.:	
Driving	19- 3
Rigid	12- 10
Engine, total	47- 4
Engine and tender, total	96- ½
Wheels, diameter outside tires, in.:	
Driving	74
Front truck	36
Trailing truck, front	38
Trailing truck, back	44
Engine:	
Cylinders, number, diameter and stroke, in.	2-26×32
Valve gear, type	Walschaert
Valves piston type, size, in.	14
Maximum travel, in.	7½
Steam lap, in.	1¾
Exhaust clearance, in.	¼
Lead, in.	¼
Cut-off in full gear, per cent	85
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	285
Diameter, first ring, inside, in.	90 3/16
Diameter, largest, outside, in.	100
Firebox length, in.	150
Firebox width, in.	102¼
Height mud ring to crown sheet, back, in.	73⅝
Height mud ring to crown sheet, front, in.	92⅛
Combustion chamber length, in.	72
Circulators, number	6
Tubes, number and diameter, in.	66- 2¼
Flues, number and diameter, in.	201- 3¾
Length over tube sheets, ft.-in.	21- 0
Net gas area through tubes and flues, sq. ft.	11.32
Fuel	Soft coal
Stoker	Modified Type B, du Pont
Grate type	Firebar
Grate area, sq. ft.	106
Heating surfaces, sq. ft.:	
Firebox	294
Comb. chamber	137
Circulators	105
Firebox, total	536
Tubes and flues	4,931
Evaporative, total	5,467
Superheater	2,336
Combined evap. and superheater	7,803
Feedwater heater, type	Wilson
Tender:	
Type	Water bottom
Water capacity, gal.	20,000
Fuel capacity, tons	25
Trucks	Six-wheel
Journals, diam. and length, in.	7 × 14
Rated tractive force, engine, 85 per cent, lb.	70,800
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	58.58
Weight on drivers ÷ tractive force	4.08
Weight of engine ÷ evap. heat. surface	90.03
Weight of engine ÷ comb. heat. surface	63.25
Boiler proportions:	
Firebox heat. surface, per cent comb. heat. surface	71.64
Tube-flue heat. surface, per cent comb. heat. surface	63.19
Superheat. surface, per cent comb. heat. surface	29.93
Firebox heat. surface ÷ grate area	5.05
Tube-flue heat. surface ÷ grate area	46.51
Superheat. surface ÷ grate area	22.03
Comb. heat. surface ÷ grate area	73.61
Gas area, tubes-flues ÷ grate area	0.107
Evap. heat. surface ÷ grate area	51.57
Tractive force ÷ grate area	667.9
Tractive force ÷ evap. heat. surface	12.95
Tractive force ÷ comb. heat. surface	9.07
Tractive force × diam. drivers ÷ comb. heat. surface	671.4



The Anderson spark arrester



The high-capacity boiler for the Milwaukee freight locomotives

of 7½ in. The valve events are the same as those on the earlier order of locomotives, except that the exhaust clearance has been increased from ⅛ in. to ¼ in.

A notable difference in the design of these locomotives lies in the method of counterbalancing. On the earlier locomotives, after counterbalancing all revolving weights and cross-balancing those in the main wheels, 39.5 per cent of the reciprocating weight (a few pounds less than 2,300 on each side) is balanced. At the diametral speed (74 m.p.h.) this gives a calculated dynamic augment of 11,285 lb. in each of the first and main wheels, 12,300 lb. in the third wheel, and 11,400 lb. in the fourth wheel.

On the new locomotives a departure was made from this method of balancing. Just as in the case of the former locomotives, all revolving weights are counterbalanced and those in the main wheel are cross-counterbalanced. Instead of compensating for a percentage of the reciprocating weights, however, the portion of the reciprocating weights which remain unbalanced in relation to the total weight of the locomotive was used as a basis for determining the amount of reciprocating overbalance.

For these locomotives 3.52 lb. of reciprocating weight per 1,000 lb. of the total weight of the locomotive were left unbalanced. The total weight of reciprocating parts on each side is 2,309 lb., of which 1,739 lb. remain unbalanced. The balance for the remaining 570 lb. is distributed 120 lb. in the main wheel and 150 lb. in each of the front, intermediate and back wheels. Less overbalanced is placed in the main wheel than in either coupled wheels to compensate for the vertical component of the horizontal inerita forces of the reciprocating parts and the piston load brought about by the angularity of the main rod.

The determination of the revolving and reciprocating portions of the weight on the main rod is based on the center of percussion rather than on the center of gravity. The center of percussion was determined by actually swinging the rod as a pendulum about the center of the crosshead pin.

At diameter speed the dynamic augment due to the overbalance in the front, back and intermediate wheels is 7,700 lb. and for the main wheel, 6,160 lb.

The tender is built up on a General Steel Castings water-bottom underframe and is carried on two General Steel Castings six-wheel trucks. The trucks have 7-in. by 14-in. journals which are fitted with American Steel Foundries roller-bearing units with SKF bearings. The Simplex Unit Cylinder clasp brakes have one brake cylinder per truck. The Franklin Type E-2 radial buffer is applied between the engine and tender.

The locomotives have Westinghouse 8ET brakes with two 8½-in. cross-compound compressors.

The principal dimensions, weights and proportions are shown in the table.

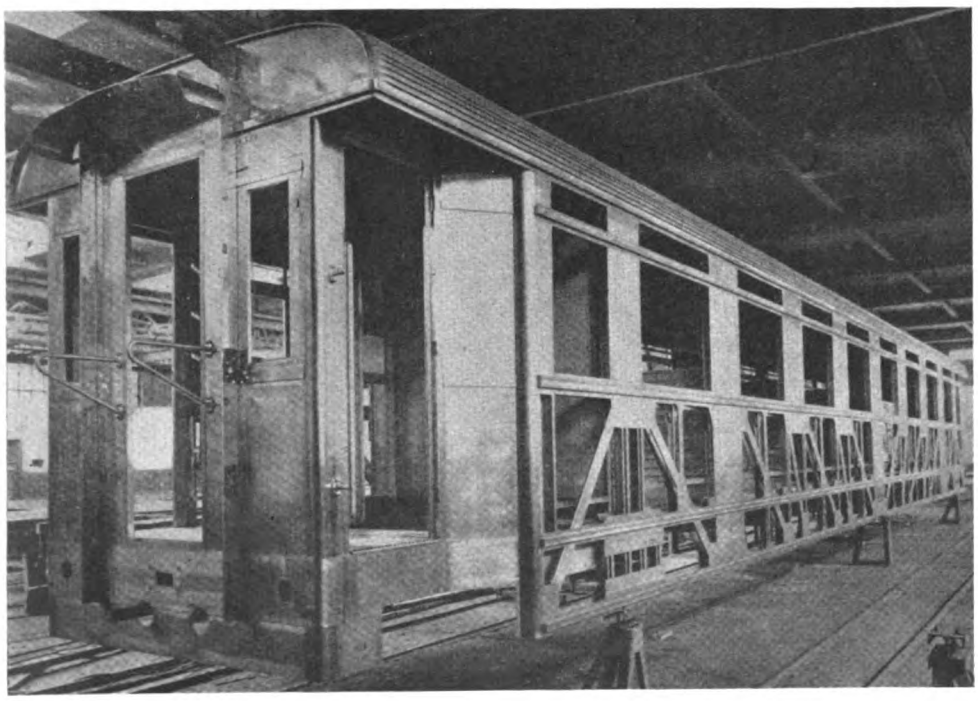
Canadian National Refrigerator Cars

(*Continued from page 215*)

temperature record of a shipment of frozen fish from Prince Rupert, B. C., to Chicago which is typical of the test runs made with this commodity. The shipment weighed 41,116 lb. and the car was billed to re-ice if the top inside temperature rose above 10 deg. F. using 2,400 lb. of ice and 25 per cent salt. It was not necessary to re-ice en route, although heretofore such shipments during the winter season were re-iced at all seven regular icing stations, and the delay incident to re-icing was eliminated.

For purposes of comparison the Canadian National ran a test in August, 1939, with one of its experimental refrigerator cars having overhead ice tanks along with a conventional end-bunker car, both loaded with bananas, from New Orleans, La., to Omaha, Neb. The temperature records of both cars are given in another table and show the average top and bottom temperatures and the temperature differences in both cars. It will be noted that it was necessary to undercool the bottom of the load in the end-bunker car in order to quickly cool the top of the load with minimum temperatures as low as 44 deg. F. being obtained. The record shows that much more even temperatures prevailed in the car with overhead icing.

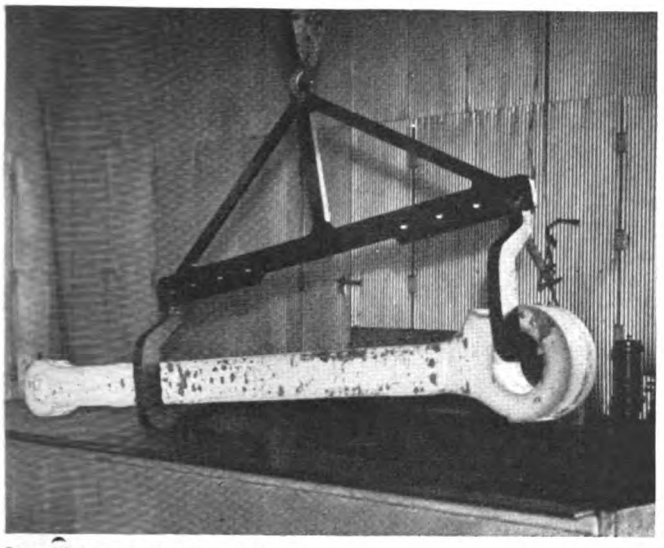
* * *



The frame of a stainless-steel rail car built in Genoa, Italy, for the Italian State Railways—The Budd Shot-weld process was used in its construction

Quenched and Tempered

Locomotive Forgings



Quenching a locomotive main rod

By

L. E. Grant*

and

J. W. Crossett†

Properly controlled methods assure longer life and higher factor of safety which more than justify the slight increase in cost

LIQUID quenching, followed by tempering, has been used for years in the automotive industries to produce a combination of high strength, toughness, increased fatigue resistance and a notable increase in resistance to wear. There is no apparent reason, except difference in size of the forgings, to indicate that similar results could not be obtained in locomotive forgings. Previous to the era of streamline high-speed trains, and even now, many of the railroads have lagged behind other industries in the application of heat treatment other than annealing, or normalizing and tempering. Liquid quenching of running-gear parts such as axles, rods and pins still appears to be viewed with some suspicion, if not actual distrust by railroad management. However, the excellent results obtained on the basis of both economy and safety with quenched and tempered tires, steel wheels, plain carbon piston rods and crankpins of relatively high hardness may be cited as evidence that distrust of liquid quenching is unwarranted. The Milwaukee's experience with some quenched-and-tempered crank pins has been especially significant. Some of these pins have been in service over 600,000 miles and had worn out of round only .005 in. after 400,000 miles.

In lightweight motion-work parts heat-treated alloy steels are essential to produce the desired physical properties. Even in plain carbon-steel forgings, designed on the basis of yield strength considerably below that obtained by quenching and tempering, the longer life coupled with freedom from costly failures more than justifies the increase in cost due to heat treatment. The general results obtained with quenched and tempered forgings have been so satisfactory on the Milwaukee that about two years ago all rod forgings made in the shop were specified to be quenched and tempered. These rods are made from plain carbon, low-carbon-nickel, or chrome-nickel steel of the compositions shown in Table I. Plain carbon steel is used for the side- and main-rod forgings on small locomotives not operated at high speeds, while alloy steels are used on the high-speed heavy-duty passenger and freight locomotives. Alloy steels are also used for eccentric and radius rods for all classes of locomotives. Except for minor variations the plain carbon and low-carbon-nickel steels correspond to the A. A. R. Specification M-105-34 while the chrome-nickel steel is S. A. E. 3130.

Billets for the various forgings are ordered large enough to insure adequate reduction in forging and are inspected and marked in the manner covered by the A. A. R. specification. Billets are stored outdoors and in winter are taken into the shop at least 24 hours before

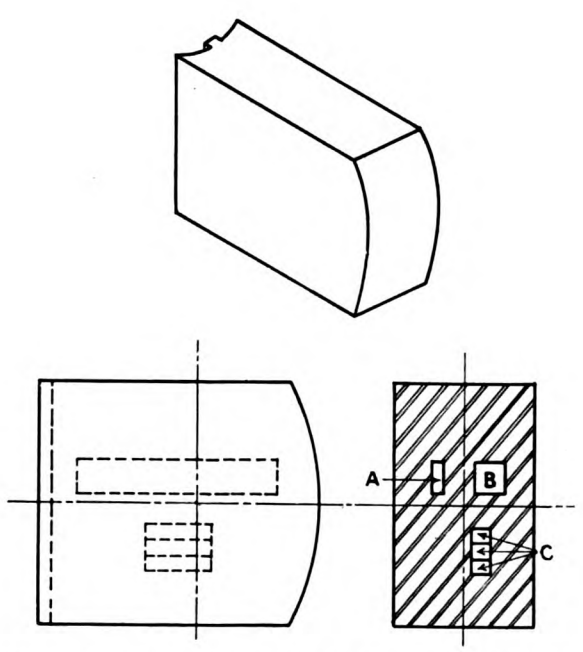


Fig. 1—Location of test bars in forging prolong: *A*, bend-test bar; *B*, tensile-test bar; *C*, impact-test bar

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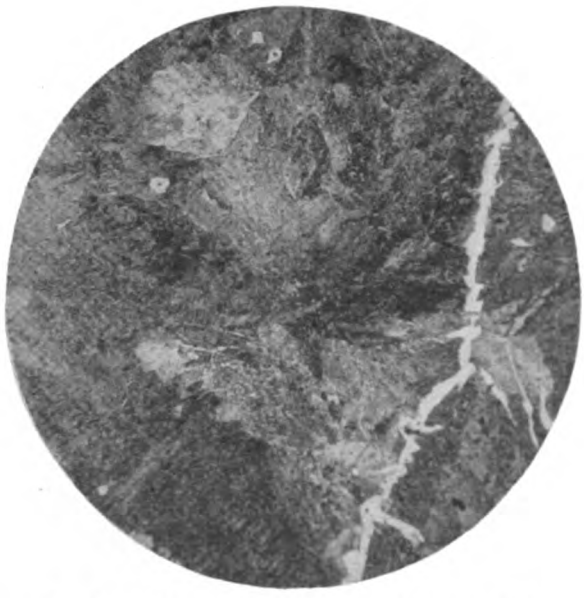


Fig. 2—Mallet main rod as forged—100 diameters

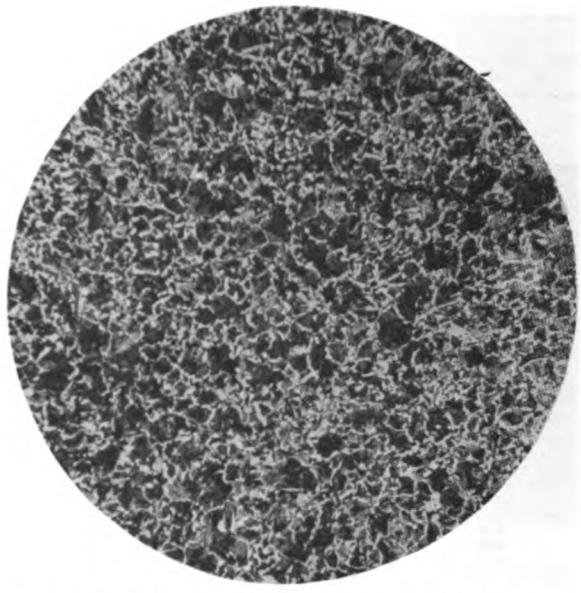


Fig. 3—Mallet main rod as quenched—100 diameters

they are to be heated for forging. Large billets are often placed in the forging furnace at the end of the day's work and left there until the following morning to insure against too rapid heating. The forging temperature varies from 2,000 deg. F. to 2,150 deg. F., depending on the material. Special care is taken in heating alloy billets to prevent overheating and the production of thick, tough scale that is extremely difficult to remove and which shortens the life of the milling cutters in machining. It has been found that the forge-shop cost on rods is considerably lower when the end contours and holes are flame cut instead of forged. The rods are preheated to about 700 deg. F. before cutting and an allowance of approximately $\frac{3}{8}$ in. is made for machining to insure the removal of all checks, decarburized, or heat-affected metal from the finished rods.

A prolong, the full thickness of the forgings and about 5 in. wide by seven in. long, stamped with an identifying serial number, is left on a sufficient number of rods to provide at least two test-bar coupons for each heat-treating charge. The prolongs remain attached to the forgings by a strip $\frac{3}{8}$ in. wide, as shown in Fig. 1. After heat treatment, one prolong from each furnace charge is broken off and turned over to the test department for physical tests. Test-bar blanks are sawed from the prolong in the manner shown in Fig. 1. The *A* portion is used for the standard 0.505-in. test bar, one face being polished for a Brinell test to determine the hardness of the forging. The *B* section is used for a $\frac{3}{8}$-in. by $\frac{7}{8}$-in. by 6-in. bend test bar. The three blanks, labelled *C*, are used for Charpy impact bars.

The rough, flame-cut rods are placed on cast-iron supporting blocks in a car-bottom furnace for heat treatment. The blocks are placed so as to support the rods substantially and still have adequate circulation. Initially the furnace temperatures were controlled manually, but since the installation of automatic temperature controls there has been a marked improvement in the uniformity of the results obtained. Unless the larger forgings are normalized before quenching, it is difficult to obtain the desired fineness of grain. All of the rods regardless of composition are oil quenched from 1,550 deg. F. and removed from the oil when they have reached approximately 200 deg. F. The oil in the quenching tank is circulated through a cooler, and forgings are not quenched if the oil temperature is above 175 deg. F. All rods regardless of composition or size are tempered at 1,200 deg. F. The time at heat is determined by the size of the forging and the properties desired. Chrome-nickel forgings are quenched in the oil bath after tempering to avoid possible brittleness. If the results of the physical tests or microscopic examination are not satisfac-

Table I—Percentage Composition of Heat-Treated Forgings

	Carbon	Manganese	Phosphorus	Sulfur	Silicon	Nickel	Chrome
Plain carbon (S.A.E. 1050)	.40–.55	.60–.90	.045 max.	.050 max.	.15 min.	.25 max.	.15 max.
Low-carbon nickel	.20–.30	.65–.95	.045 max.	.050 max.	.15–.35	2.50–3.00	.15 max.
Chrome-nickel (S.A.E. 3130)	.25–.35	.50–.80	.045 max.	.050 max.	.15 min.	1.0–1.5	.45–.75

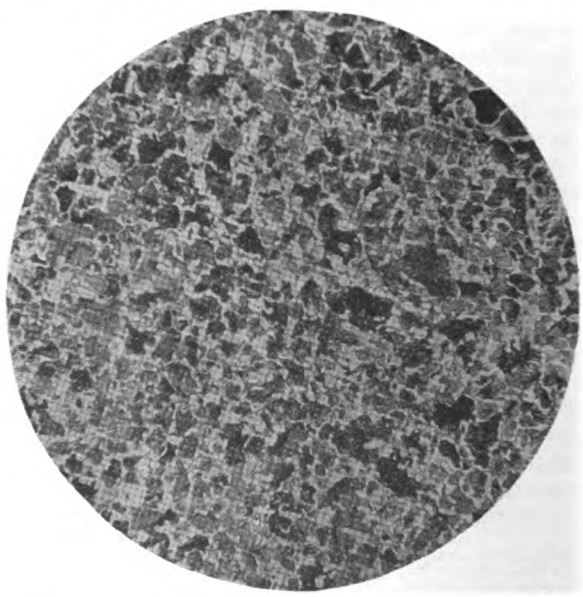


Fig. 4—Mallet main rod as normalized—100 diameters

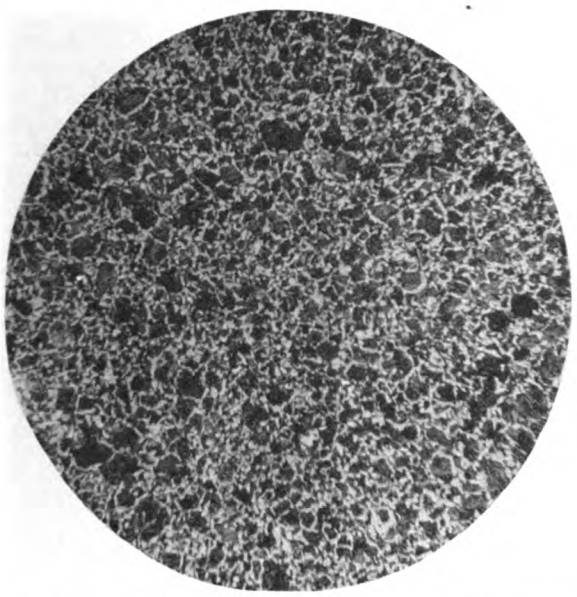


Fig. 5—Mallet main rod, quenched and tempered—100 diameters

tory, the lot is given additional treatment as may be required to produce the results desired. In the event that the treatment is repeated, a new set of test bars is made from another prolong. Due to failures definitely attributed to notches and deep tool marks it has been deemed necessary to polish all rods to remove sharp corners and tool marks. The polished rods are stamped with a serial number to identify them. A record is maintained connecting the serial number with the date of manufacture, heat treatment given, physical properties obtained, and composition of the steel.

Table II—Average Physical Properties of Heat-Treated Rods

Class	Type	Yield point, lb. per sq. in.	Tensile strength, lb. per sq. in.	Per cent elongation in 2 in.	Per cent reduction of area	Brinell hardness	Ft. lb. Charpy
Main	Plain carbon	56,000	93,900	26.6	48.8	192	28
Main	Low-carbon-nickel	67,300	92,200	28.5	66.3	202	—
Side	Plain carbon	60,500	100,100	25.9	53.0	192	29
Side	Low-carbon-nickel	75,400	97,600	28.1	66.3	196	65
Small	Low-carbon-nickel	70,980	95,500	28.5	64.6	196	65
Small	Nickel-chromium 3130	59,800	92,200	29.8	67.0	192	68.5

The rods may be divided into three groups according to size; namely, main, side, and miscellaneous, the latter including radius and eccentric rods. These three types may be further subdivided according to composition. The main and side rods are plain carbon or low carbon nickel, the miscellaneous rods being either low carbon nickel or S. A. E. 3130. Table II shows the average physical properties obtained with each type made in the past two years.

Table III—Effect of Heat Treatment on Properties of Carbon Steel

	As forged	Normalized	Quenched	Quenched and tempered
Yield point, lb. per sq. in.	49,700	43,300	68,300	54,400
Tensile strength, lb. per sq. in.	98,450	85,200	106,400	94,400
Per cent elongation in 2 in.	13.0	24.0	16.0	28.5
Per cent reduction of area	14.4	35.9	34.7	56.0
Charpy impact reading	9.2	13.2	17.7	29.0
Brinell hardness	196	163	207	196

A few of these rods were of the lightweight type, but the majority were made to the old design based on normalized plain carbon steel. Heat treatment of the latter class was not intended to develop the maximum strength of the steel but was adopted to provide a larger factor of safety in operation and to increase resistance to wear. Many of the locomotives on which these parts are used are in much heavier service than they were several years ago and it was desired to furnish material with a higher fatigue strength. The higher tensile, yield point, and impact values are obtained with no sacrifice in ductility. Actually the ductility is somewhat higher than can be obtained consistently in normalized and tempered steel of considerably lower strength. The high impact values of the alloy steel as compared with the plain carbon steel (Table II) is noteworthy. If impact strength is accepted as a measure of the ability of the steel to withstand occasional overloading without developing fatigue cracks, the value of both the heat treatment and alloy additions is apparent.

The question may be raised as to why plain carbon steel is used at all for rod forgings in view of the better properties obtained with alloy steel. The reason for



Fig. 6—Chrome-nickel rod, quenched and tempered—100 diameters



Fig. 7—Low-carbon-nickel rod, quenched and tempered—100 diameters

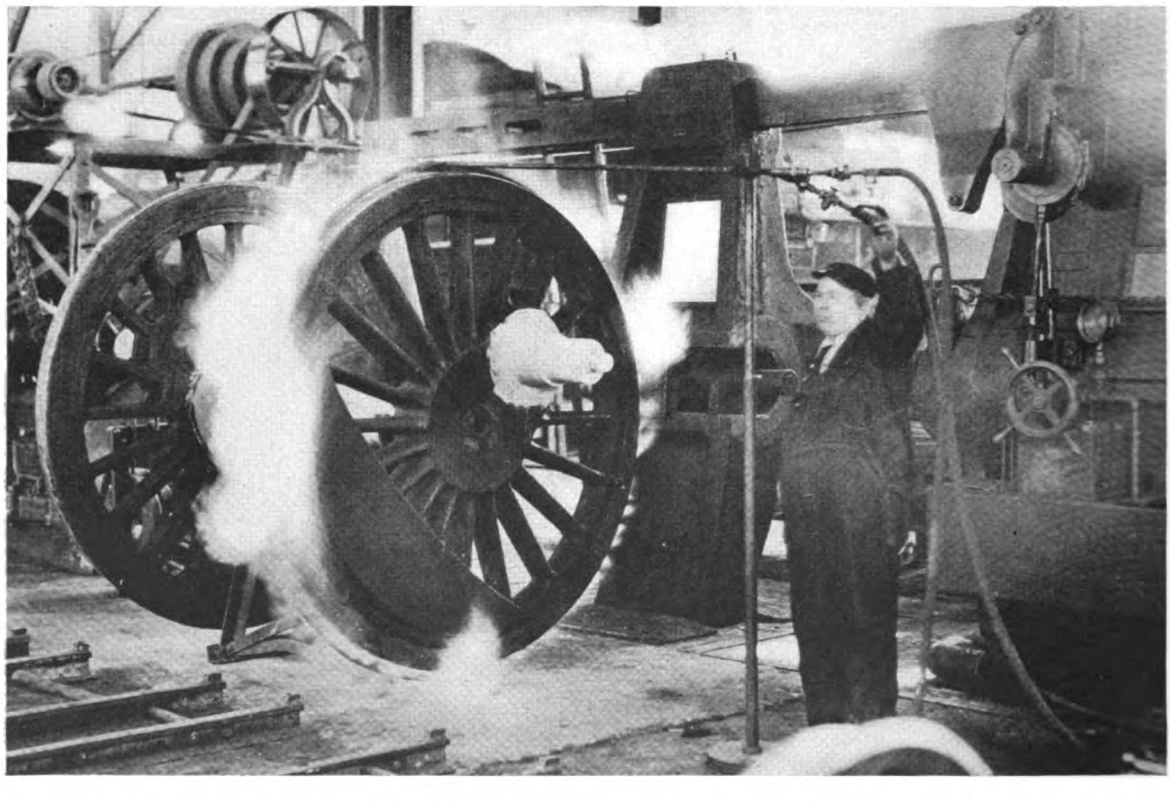
this is the fact that many of the locomotives are of the older types, operating under less severe conditions than the new power. The properties of the heat-treated plain carbon rods are so much superior to the untreated unalloyed type that the increased cost of alloy forgings did not appear justifiable. As explained above, safety and increased wear resistance were the main objectives.

One of the earlier orders for heat-treated carbon-steel rods includes a set of four main rods for a Mallet locomotive. In order to make a comprehensive study of the benefits derived from heat treatment, prolongs were left on each of the rods to furnish enough specimens to make a complete examination of the forgings during each step of the treatment. One prolong was removed after each step of the manufacturing operations; i. e., forging, normalizing, quenching, and, finally, after tempering. Each of these prolongs was handled in the manner described above for the finished rods. The results are given in Table III. Normalizing reduced the "as forged" yield point and tensile about 13 per cent, while the elongation was increased 150 per cent and the reduction in area 44 per cent. The yield point and tensile strength of the "as forged" rods were very good but the ductility was too low, indicating a rather brittle condition. Quenching raised the yield point and tensile strength values above those obtained after forging, while the elongation and reduction in area were decreased slightly from the normalized state but were much better than in the "as forged" condition. Tempering brought the yield point and tensile strength down to the desired values and at the same time raised the ductility producing the best balance of physical properties obtained in any of the treatments. The rods in this final state have superior physical properties compared to the normalized and tempered rods formerly used in this service. One of the most remarkable changes brought about in heat treatment was the increase in Charpy impact values. The "as forged" bars had an impact value of only 9 ft. lb. and this was raised almost 50 per cent to 13 ft. lb. by normalizing. Quenching increased the value to about 18 ft. lb., while tempering raised it to 29 ft. lb. This is about average for forgings of this character.

The microstructures of the rods in the various stages are shown in Figs. 2 to 5 inclusive, and are helpful in understanding the changes in physical properties. The "as forged" rods had an extremely coarse grain structure surrounded by a network of ferrite, which accounts for the low ductility. Normalizing broke up the coarse continuous ferrite network, and reduced the size of the pearlitic grains. Increased ductility accompanied by lower yield point and tensile strength resulted from this treatment. Quenching refined the grain somewhat further and raised the hardness and tensile strength with little change in ductility. Final tempering converted the steel to fine-grain ferrite and sorbite. Steel in this condition is tough, reasonably hard and strong, yet has sufficient ductility to withstand shock loading without developing cracks. Figs. 6 and 7 show the structure of similar rods of chrome-nickel and low-carbon-nickel steel quenched and tempered.

It is confidently expected that liquid quenching of plain carbon steel followed by tempering will be extended to other parts. The benefits obtained are so important that the slight increase in cost per forging can easily be justified. The longer life obtained by the increased hardness will of itself justify the cost of heat treating. The margin of safety is of itself worth more than any increase in cost. When one considers that quenching and tempering produces forgings with the ductility and impact strength of low-carbon steel combined with the strength and hardness of higher-carbon steels, there ought not be much question as to the desirability of such material for use on modern locomotives. Obviously the heat treatment and tests must be controlled by trained personnel.

* * *



Equipment used in changing driving-wheel tires at the Sacramento, Cal., locomotive shops of the Southern Pacific

Problems of

Freight-Car Weight Reduction*

By V. R. Willoughby†

A discussion of the possibilities of weight reduction offered by the low-alloy high-tensile steels in which is pointed out the penalty imposed by the empty-and-load brake rule

EXCESSIVE dead weight in railway vehicles is serious in that, while the track is as level as practical, still there are grades to negotiate which take power to ascend and require retarding means to keep from excessive speeds in descending. Experience has fairly well established the strength requirements of the vehicle under normal operating conditions. Abnormal conditions such as collisions and wrecks are an entirely different story.

Let us look into the history of the railway car. Railway car designers have taken the materials used in other industries, in fact very seldom have there been any materials devised especially for railway car construction. The early cars were made principally of wood with metal running gear, wheels, axles, bearings, boxes, etc., that is, metal was used where the service demands were such that wood was not suitable. The introduction of metals in the car structure, other than running gear, was gradual and it was not until about the beginning of the present century that we had the all metal freight car. In the design of this car engineers used materials and certain methods of construction already developed to a high degree in the construction of bridges and other steel structures.

As a large number of vehicles are built from a single design, any saving in one unit reflects largely in the cost of an order for cars, which often runs from the hundreds into the thousands. It is clearly evident that the question of weight must be carefully scrutinized. Every pound of dead weight added to the individual car structure is multiplied many times in the train and calls for a correspondingly increased tractive force from the locomotive.

Years of study of failures have enabled those engaged in railway car design and operation to set up certain standards of strength. These, of course, are all based on normal operation with the cars on the rails. When the cars left the rails, due to derailment or wrecks, cars became damaged, as it is absolutely impracticable to design railway cars which can be operated economically and attempt to meet such drastic conditions.

The World War taught us a great deal in the way of improved materials. The automobile required further refinement in metals. The aeroplane has had a marked influence on other types of materials and methods of construction. The railway car is subject to all kinds of weather. Many cars are subject to the corrosive influence of the lading. The car design engineer must take all these into account. Corrosion, especially atmospheric, takes a great toll out of railway car equipment.

The metallurgists have progressed far in providing improved materials. Numerous designs of cars have been brought out using these improved materials.

Evolution of Weight Reduction

From a freight-car standpoint, the approach was as follows:

What improvement can be made in the existing types of cars utilizing low-carbon open-hearth steel and riveted construction? A concrete example of the results of this study is the A.A.R. standard box car, approved by the A.A.R. in 1932. The standard 50 and 70-ton hopper cars followed shortly thereafter. The weight saving in these cars was substantial but not sufficient to render obsolete the large amount of equipment which in reality had become expensive to run. These designs were based on the best engineering data available and set up standards of strength which experience had shown to be about the best balance that can be obtained between the strength and weight of the car commensurate with its economic operation.

Realizing that much more must be done in the way of lightening our rolling stock and adding to its service life, alloy steels were next considered. The development of the low-alloy high-tensile steel, with its increased resistance to corrosion under atmospheric conditions, and its substantial increase in strength, provided the car designer with a very good material with which to effect substantial savings in weight. Even though the members were materially lightened, the fact that these low-alloy high-tensile steels were better rust resisting, the thinner materials should give equal or better life than the thicker members of low-carbon open-hearth steel. On the other hand, the higher tensile strength permitted substantial weight savings in the heavier members of the car structure. Numerous cars were built, including open top as well as house cars.

With the use of the higher strength materials and the thinner section it was realized that the method of construction should be changed. Where you rivet thin sheets to heavier frame members, the weak point is generally the bearing value of the thin sheet on the rivets. Again, a riveted joint does not permit the full section of the material to be available as deduction must be made for rivet holes, especially in members subjected to tension.

Some designers, as far as government regulations will permit, want to weld the entire structure. In quantity production there is an economic limit to the substitution of welding for rivets. There are certain places in the car structure where rivets are more advantageous. From the quantity-production standpoint the welding torch is not desirable, or at least should be kept to a minimum, on the final assembly or building track. Where parts may be joined in what we call sub-assemblies the work can be scattered over a sufficiently large area so that the ill effects from the bright light of the welding torch may be practically eliminated.

There are places where the spot weld gives the best method of attaching the various members together. This calls for, in many instances, rather elaborate machines,

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* From a paper presented before the New York Chapter of the American Society for Metals at New York, May 13, 1940.

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but because of the large number of units, in a substantial order for cars, the saving that may be effected by the use of these machines is sufficient to warrant their use.

The standard box car of today, to the latest A.A.R. design, in low-carbon open-hearth steel weighs in the neighborhood of 45,000 lb. Since this design was made up there are certain operating features, such as additional floor stringers required for tractor loading service and means of removing floor boards without interfering with the lining, which are very desirable. If these additional features are incorporated in this A.A.R. standard car they would increase its weight to well over 46,000 lb.

What Can Be Done with High-Tensile Steels

By the use of low-alloy high-tensile steels a very marked saving can be made in the weight of this car. Cars have been built with weights from 36,000 lb. up. From the economic standpoint, a car using grade B steel castings, chilled iron wheels and center sills of low-carbon open-hearth steel, is perfectly feasible and will be in every way comparable from a service, strength and life standpoint with the 46,000 lb. A.A.R. car and weigh about 40,000 lb. That is, 6,000 lb. may be saved, which is a saving of over 13 per cent. In other words, a train of 100 box cars weighing 46,000 lb. each, would have a dead weight of 4,600,000 lb. while a train of the 40,000-lb. cars would weigh 600,000 lb. less. Putting it another way, the dead weight of the train having 115 new cars would weigh no more than 100 A.A.R. cars built of low-carbon open-hearth steel.

The statement has been made that it costs approximately $18 a ton per year to haul dead weight. If this is true, then every one of these low-alloy high-tensile steel box cars that weighs 40,000 lb. versus 46,000 lb. (that is, 3 tons less), would show a saving in hauling cost of $54 a year.

Let us consider the open-top car. The weight of the A.A.R. design of the nominal 50-ton car, that is equipped with 5½ in. by 10-in. journals, is given as 41,562 lb. Due to the Interchange Rules it is permissible to load a car equipped with 5½-in. by 10-in. journals to 169,000 lb. on the rail—this figure representing tare weight plus pay load. This standard A.A.R. hopper car may carry a load of 127,438 lb.

What could be done with this car in low-alloy high-tensile steel? Cars have been built, equipped with 50-ton trucks, having a tare weight of not much over 30,000 lb. However, it is perfectly feasible, following the lines given for the box car, to design a hopper car with a nominal capacity of 50 tons, in which the weight should not exceed 35,000 lb. This would permit a pay load of 134,000 lb. This is an increase in pay load of about 6,560 lb., that is over 5 per cent—certainly a substantial amount.

The cost of hauling these cars loaded with this extra pay lading of over three tons, would be the same as the low-carbon open-hearth steel loaded with the three tons less capacity, but when empty the cost would be less because there would be over three tons less dead weight to haul. The extra revenue from the three tons extra lading is substantial. The same results are obtainable in other types of freight cars.

The Braking Situation

This would be very fine if it were not for certain A.A.R. rules that must be followed.

The braking power for a freight car of this class must be not less than 60 per cent, nor more than 75 per cent of the light weight of the car, and should be not less than 18 per cent of the total rail load limit, otherwise the empty-and-load brake should be used.

For a car equipped with 5½-in. by 10-in. journal trucks, the rail load limit is 169,000 lb.; 18 per cent of this is 30,420 lb. which is the minimum braking power we may have if we live up to the recommendations. This braking power is 75 per cent of 40,560 lb. which is the lightest car recommended for the single brake. This rule is not strictly adhered to, but a car with a light weight of 35,000 lb. with only a single brake would be too flagrant a violation of the rules.

This braking rule imposes a severe penalty on the savings, otherwise attainable by the use of modern materials and construction methods in these hopper cars. The extra initial cost for the empty-and-load brake is about $200, and the additional weight penalty is about 500 lb.

What kind of material is best suited for freight-car construction?

Our experience has shown that for car body designs, we need a steel that is ductile, easily worked (both hot and cold), corrosion resistant, of high fatigue value especially at lower temperatures, must be readily weldable and be in the low-price range.

Low-carbon open-hearth steel is an ideal material, except for two features; namely, its tensile value and low corrosion resistance. The low-alloy high-tensile steels that have been introduced and are best suitable for car construction are those where the yield point is something over 50 per cent more than the low-carbon open-hearth steel and where there is a substantial ratio between the yield and the ultimate. To be suitable for car construction this steel should be as easily worked as low-carbon open-hearth steel except for the increased strength. It should have a substantial increase in corrosion resistance, especially against atmospheric corrosion and should have good shock resistance at the low temperatures through which cars must operate in the winter time. It is extremely essential that this steel be readily weldable without air hardening.

The price differential as compared with low-carbon open-hearth steel must be such that the weight savings permissible due to the increased strength and better corrosion resistance may absorb practically all the increase in cost.

There are a substantial number of cars in service utilizing various brands of low-alloy high-tensile steels and, as far as I have been able to learn, these steels are giving a satisfactory account of themselves. Only time will give the answer to their true value in comparison with low-carbon open-hearth steel and with each other.

[Mr. Willoughby also discussed a number of interesting tank-car developments and concluded with a brief discussion of the use of modern structural materials in passenger cars.—Editor.]

* * *



Photo by C. Parker

A "double-ender" and train in local service on the Boston & Albany at Newton Centre, Mass.

EDITORIALS

Availability of Steam Locomotives

There are some roads on which consistent effort has been put forth to increase the utilization of locomotives. Generally speaking, however, the urge to do so is not nearly so great in the case of the steam locomotive as it is in the case of the Diesel-electric locomotive.

The inventory of steam locomotives, particularly those for freight service, is based on the peak traffic demands for which motive power must be available. Except for the relatively short periods of peak demand, a surplus of motive power is available so that the need for intensive utilization is far from continuous.

Since the urge for intensive utilization on the part of the operating department is not great, the mechanical department finds itself under relatively little pressure in the matter of availability except during the period of peak demand. Some mechanical departments, however, have made a particular effort to keep down the number of active locomotives because there are some increases in expense which vary with the number of locomotives being handled irrespective of the intensity with which they are being used.

In the case of the Diesel-electric locomotive, because of the high first cost, intensity of utilization is one of the first considerations. The particular advantage of these locomotives in the matter of availability is freedom from the necessity of fire cleaning. Those in passenger service are equipped with steam-heat boilers which require practically the same periodic inspections and tests as the steam locomotive boiler, so that the only advantage the Diesel-electric locomotive has in this respect is the shorter time required to complete the tests. In the matter of fire cleaning the disadvantage of the steam locomotive is more psychological than real.

Twenty or more years ago there were probably very few railroad men who thought it feasible to operate a steam locomotive for more than about 200 or 250 miles without servicing. Then came the rapid spread of interest in long locomotive runs, first in freight service and then in passenger service, and it was soon demonstrated that with the proper technique of handling the fire the only services required at intermediate terminals on the long runs were the dumping of the ash pan and attention to lubrication. The latter has now ceased to be a problem, at least as far as the newer locomotives are concerned.

During this period it was also clearly demonstrated that locomotives could be kept under steam without knocking the fire for periods much longer than would be required by any conceivable continuous runs. On the St. Louis-San Francisco a freight locomotive operated 7,350 miles in 1929 without dumping the fire. A year later another freight locomotive on the same railroad operated for 31 days, during which time it made 9,700 miles with crews changed 79 times, with a single fire. During this demonstration the average time of cleaning fires at terminals was about 25 min.

What now needs to be done with respect to these under-utilized capabilities of the steam locomotive is to reappraise the possibilities for further reducing the total amount of motive power required to meet the maximum traffic conditions. On some railroads at least, with the purchase of modern high-capacity freight locomotives, a heavy proportion of the main-line traffic has been handled by a relatively small assignment of the new power. Such locomotives have proved their ability to stay out of the back shop for well up toward 300,000 miles and their ability to average a high daily mileage.

There are, of course, two problems involved in obtaining the ultimate objective. The first is the provision of a maximum of availability by the mechanical department. The second is the utilization by the operating department of the locomotive hours provided by the mechanical department. If an appreciable reduction is to be made in the number of locomotives required in an assignment, however, the first problem lies with the mechanical department.

A renewal of interest in developing the possibilities for greater availability to the full would place the comparison of steam and Diesel-electric locomotives on a fairer basis in this respect. The advantage to the railroads of the low first cost of the steam locomotive will then not be lost without a clear demonstration that it is fully offset by other factors inherently beyond the attainment of the steam locomotive.

The Value of Modern Equipment Is Now Evident

From the standpoint of equipment maintenance American railroads are definitely faced with these important factors: a shortage of skilled mechanics; a shortage of modern shop equipment; an increasing demand for limits of accuracy in shop work as a result of higher operating speeds, and a probable increase in the demand for power as a result of national defense programs. Add all of these things together and it would appear that we are faced with necessity of doing some-

thing about several problems that have been sidestepped under the pressure for reducing operating expenses during the past 10 years.

This is not an appropriate time to call attention to the shortcomings of the past for there are more important matters to be dealt with and the question now is what kind of an intelligent program can be developed for doing a job that is confronting the roads.

Concerning the question of skilled help it may be worth while to call attention to the fact that there are now employed by the railroads about 124,000 machinists, blacksmiths, boilermakers, sheet-metal workers and their helpers and apprentices engaged in the maintenance of motive power. Any attempt now to augment this labor force is going to have to be done in competition with the requirements of all of the industries that will be engaged in supplying the needs of our defense program. The fact that the total number of employees in the above classifications is but slightly more than half of what it was in 1929 and only about 2,000 more than it was in 1933 is both an indication of what has happened to the maintenance forces over a period of 10 years and how little has been done in the past six years to anticipate and prepare for the conditions which we will probably now be required to meet.

The lack of modern shop equipment and the increasing demands for accuracy in shop work are two elements that go hand in hand. It is unfortunate that in railroad shop work the opportunities for cutting the costs of production have been limited by the great varieties of work to be handled and the small quantities of identical parts required. Because of these facts it has been the exception, rather than the rule, that new shop equipment could be justified on the basis of returning as much on the investment as might be the case in industries where greater work volumes prevail. On the other hand there are numerous outstanding examples, in railroad shops, where by consolidation of work at central points the volume of work has been increased, even under depression conditions, to a point where new equipment was installed and the results have demonstrated the economies to be far greater than was expected.

The average railroad demands a return of at least 17 to 20 per cent on the investment in order to justify the purchase of new shop equipment and because the way has not been found to meet this requirement management has arbitrarily decided against new installations in many instances where a little further study would have shown the way to major savings. Instances that have come to light in the past year where new installations have been made and have resulted in returns of from 50 to 60 per cent annually illustrate what can be done.

As matters stand at this moment it is apparent that the railroads are going to be called upon to play an increasingly important part in the events that are to come and it is worth while to take stock with a view to determining what condition they are in to meet the situation. It is of little comfort to say that out of the thousands of unemployed in this country the ranks of the railroads can be filled out when it is common knowledge that the reason for the shortage of skilled mechanical craftsmen is that the ravages of time and our past indifference to the training of men have combined to create a situation wherein there are not enough trained men to go around and not enough time to train them. The course that can be taken is to study the possibilities of further consolidating railway repair operations at central repair points and of equipping those points with such modern facilities as can be secured under present conditions. The competition in the purchase of needed equipment will be just as keen as it will be in the effort to build up shop forces and the most important immediate job is that of determining what kind of and how much equipment will be needed. Industry has been told through all the years of the depression that modernization of plant equipment would be its ultimate salvation in the matter of keeping costs under proper control. As far as the railroads are concerned it probably will not only be a matter of cost control but the only available solution to a production problem involving increased output with existing forces.

How to Increase Freight-Train Speeds

Mechanical-department forces, both locomotive and car, are definitely responsible for providing adequate motive power and freight cars in condition to operate safely at the high speeds necessary to meet modern shipper requirements. As was pointed out by A. R. Ayers, general manager, Nickel Plate, in a paper presented at the April 16 meeting of the Car Department Association of St. Louis, however, there is a growing appreciation that the way to increase the *average* speed of trains between terminals (which is what shippers are interested in) is to pay at least as much attention to reducing delays as to securing high maximum speeds.

The adverse effect of a few minutes delay may be illustrated by the following example: Let us assume that a freight train, in making its schedule and effecting proper deliveries to connections, must operate over a distance of 100 miles at an average speed of 45 miles an hour, or one mile in 80 seconds. If this train meets with a delay of 20 minutes on account of an air compressor failure, a steam leak in the locomotive front end, a hot car journal or a brake beam down, this means 1,200 seconds, which must be made up over the 100-mile run, or 12 seconds per mile. Instead of having 80 seconds to run a mile, therefore, the train can have only 68 seconds, which corresponds to a speed of 53 miles an hour. In other words, to make up the 20-minute delay, the speed of the train must be increased from 45 to 53 miles an hour over the entire 100 miles. When slow average speeds were the rule, there was more margin for making up delays, but it

is easy to see that with the higher speeds of operation today, if the delays reach any considerable amount, they can often be made up only with the greatest difficulty, if at all.

Regarding the influence of delays on motive power and car requirements, Mr. Ayers said "Locomotives will not haul as much tonnage at high speeds as they will at low speeds so that, other things being equal, it requires more train service to handle a given volume of traffic at high speed than it does at low speed. It is therefore evident that any increase in train speeds, brought about by unavoidable delays, causes an unnecessary increase in the cost of operation.

"Train speeds on the road compare quite favorably with the speed of highway vehicles but rail traffic is subject to heavy delays getting through yards, particularly large terminals, and it is here that railroads have a great opportunity. If the inspection, switching, pumping of air, and final air tests are done one at a time, the total time of the train in the yard is the sum of the time of all four operations. To the extent that these operations can be performed simultaneously instead of one at a time, it is possible to affect great savings in time. I will not go into the detailed ways in which this can be done, as operating conditions govern, but I do know that attention to this feature has in some cases reduced the time of getting trains through the yard to considerably less than half of what it used to be. . . .

"Railroads can do a great deal for each other if they maintain their own freight-car equipment to as high a standard as possible and thus keep it off their neighbor's repair track and give him more time to maintain his own equipment. If this results in a higher unit cost for general repair, the difference will at least be made up by a reduction in running repairs and with the great benefit of having cars available at all times between general repairs and in shape to move freight without delay or interruption so far as mechanical defects are concerned. When cars are on repair tracks for any reason they should receive not only the repairs for which they are carded, but should be thoroughly inspected so that any other impending defects can be taken care of and thus avoid another repair-track movement. You have all been bothered with defects which appear on loaded cars. If the repair methods which I have described are followed, many troublesome situations that sometimes result in serious delays to important freight will not occur."

Similar attention to motive power at the time of periodic inspection and repairs will go far to assure the possibility of intensive and reliable locomotive service until the next repair. Mechanical-department forces are indeed an important element in modern railroading and it is essential for supervisors in both the locomotive and car departments to familiarize themselves with and recommend the installation of improved equipment and devices which have demonstrated the ability to provide better service or reduce costs.

Since some of the rules under which railroad men are now working are a heritage from earlier days when equipment was less reliable and less well maintained than it is now, these rules should be subject to constant study with a view to revision to meet present-day requirements. As Mr. Ayers so forcefully expressed it "Restrictive rules are not for the ultimate good of those who make their living from the railroad business because by delaying the prompt and free movement of equipment they will simply drive business off the railroads to their competitors where too much of it has already gone. This country will continue to grow and the surest way for the railroad business to expand is to give the customer constantly more for his dollar. That a great deal has been done in this direction is evident from statistics which show a marvelous improvement in the average speed of railroad trains, faster schedules, much greater reliability in making published schedules and an increasing proportion of traffic being handled in scheduled fast trains."

Mechanical department forces may well feel a healthy glow of satisfaction at the important part which they have played in achieving these objectives and at the same time maintaining an enviable record for safety. The maintenance of these records, however, can be assured only by unceasing vigilance and competent, careful attention to every last detail associated with the design, construction, maintenance and interchange of railroad equipment.

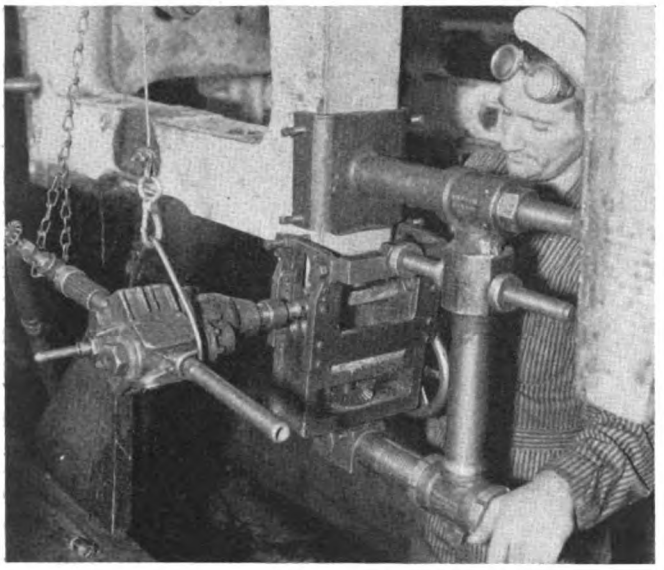
New Books

PROCEEDINGS CAR DEPARTMENT OFFICERS' ASSOCIATION, 1939.—*Published by the Association—Secretary-treasurer, F. L. Kartheiser, chief clerk—mechanical, Chicago, Burlington & Quincy, Chicago. 251 pages. Price $2 (including membership fee).* The proceedings of the annual convention of the Car Department Officers' Association, held at the Hotel Sherman, Chicago, October 17, 18 and 19, 1939, contain the reports of the committees on Freight and Passenger-Car Construction and Maintenance; Shop Operation, Facilities and Tools; Passenger Train Car Terminal Handling; Lubricants and Lubrication; Use of Freight Equipment for Loading Contaminating Commodities; Interchange; Loading Rules; Billing for Car Repairs, and Painting. Included also in the proceedings are the addresses by D. J. Sheehan, superintendent motive power, C. & E. I.; C. H. Dietrich, executive vice-chairman, Freight Claim Division, Association of American Railroads; LeRoy Kramer, vice-president, General American Transportation Company, and L. W. Baldwin, chief executive officer, Missouri Pacific Lines, Mr. Baldwin's address was presented before the third annual meeting of the Coordinated Associations—the Master Boiler Makers' Association, the Railway Fuel and Traveling Engineers' Association, the Locomotive Maintenance Officers' Association, and the Car Department Officers' Association.

Paducah Shop

Jigs, Fixtures and Devices*

By G. H. Raner†



Portable machine milling a locomotive frame pedestal jaw

THE newest large locomotive shop in this country is that of the Illinois Central, located at Paducah, Ky. Relatively little has been said in publications about this modern shop which has now been in existence almost 13 years, having turned out its first general-repair locomotive in September, 1927.

In a plant of this magnitude, where such rehabilitation work as well as fabricating, forging and finishing new parts is carried on, there is a continual need for close attention to the seemingly little things which in the aggregate present the opportunity for large savings of time and materials. In normal locomotive repair work at this shop, many jigs and devices are continually being perfected to improve both the quality and quantity of shop work, often at reduced unit cost. A number of labor-saving devices, developed and successfully used at Paducah shops, are shown in the illustrations.

Properly Fitting Locomotive Frame Binders

In order to machine a smooth surface for exact fitting of frame binders to the pedestals at each driving-wheel location, what is known as a frame pedestal-jaw milling machine is used, consisting of a device fastened between the frame pedestals by means of a bracket and screw construction. A milling cutter, operated by an ordinary reversible air motor, is supported from the balancer shown in the illustration. Vertical feed is effected by a hand wheel. Only metal enough is taken off the frame jaws to clean them properly and leave a smooth surface. Binders are then machined accurately to size, as checked by special gages, and this process assures a good binder fit and obviates loose binders and frame breakage difficulties at this point.

Drilling Locomotive Main Pins

A holding device for use in drilling center holes in new main-wheel crank pins is shown in one of the illustrations. The clamp was cut by an acetylene torch from a piece of 19-C steel 1½ in. thick, made in about two-thirds of a circle, which allows removing and replacing a pin without taking the clamp from the drill-press table. The usual 1-in. T-bolts are used to hold the clamp to the table and there are three set screws for clamping the pin itself, these screws being spaced 120 deg. apart and threaded into nuts which are welded to the clamp. After being centered, the crank pin is lifted by an electric hoist and C-clamp arrangement, a photograph of which is also shown, and placed on a center which is inserted in the bed of the press on the bottom table. The drill spindle is set in line with the center in the bottom table and the crank pin adjusted at the top by the three holding screws until its center is in line with the drill. The pin is therefore set up and held in place with no measurements taken.

It will be noticed in the illustration that two of these clamping devices are used on the same drill press. The former method of clamping the pin against wooden blocks for holding required twice the time in clamping.

Drilling Gib-Bolt Holes in a Crosshead

On the drill-press table is shown a jig for drilling holes in forged steel locomotive crossheads for the bolting of the shoe to the crosshead. This consists of two side plates with wings which extend inside of the crosshead-shoe fit and are drawn together with a 1-in. bolt 24 in. long. The plates are made of forged steel. There are four holes properly spaced in each of the plates in which case-hardened bushings are applied. The crosshead itself with the two side plates applied is held down on the drill-press table by an ordinary clamp bolt. This arrangement permits drilling these holes in one-half the time formerly required and, of course, obviates the former method of laying out each individual crosshead before drilling.

Cutting Fibre Liners

A tool for cutting circular fibre liners from a rectangualr sheet is also shown on the drill press. The cutter holder is adjustable to any size liners needed from 6½ in. to 13½ in. Adjustment is made by a key which may be seen and is held by a set screw in each end. The cutters or blades are made of high-speed steel. The fibre is furnished in large sheets from which liners are laid off to size by a templet and then held for cutting out by nailing sheets to a wood platform placed on the drill-press table. In the center it will be noticed that a small drill is used as a lead to prevent material from chattering while cutting. These liners are used on crossheads to prevent galling of the head and front end of the main rod.

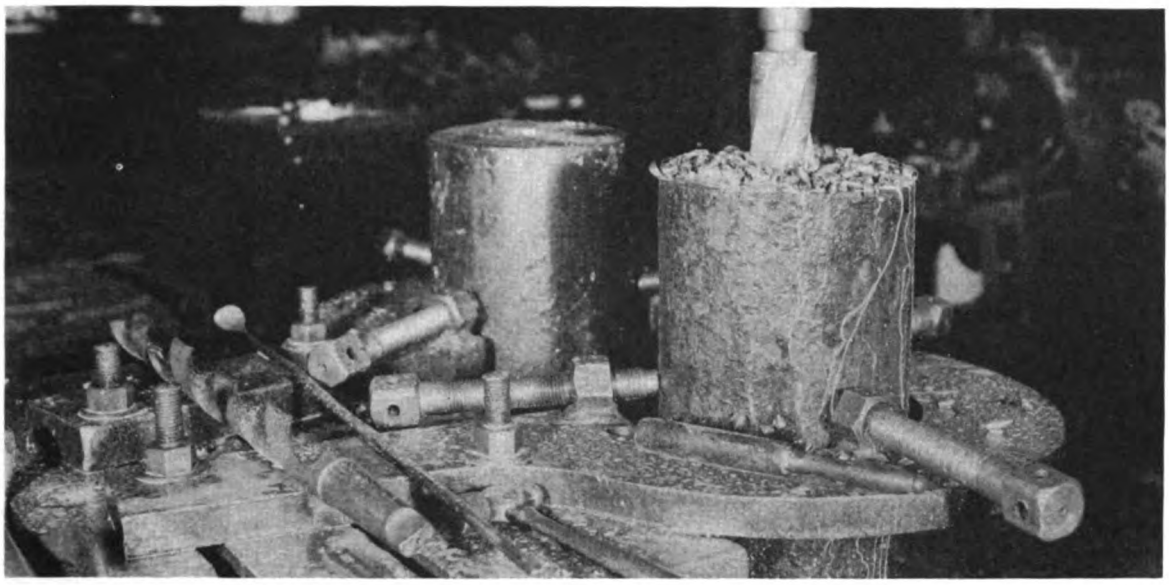
The former practice in making these liners required three different operations in the process of cutting one out. This arrangement permits increasing the number of liners cut in a given time by one-third.

Placing a Hot Tire on a Wheel Center

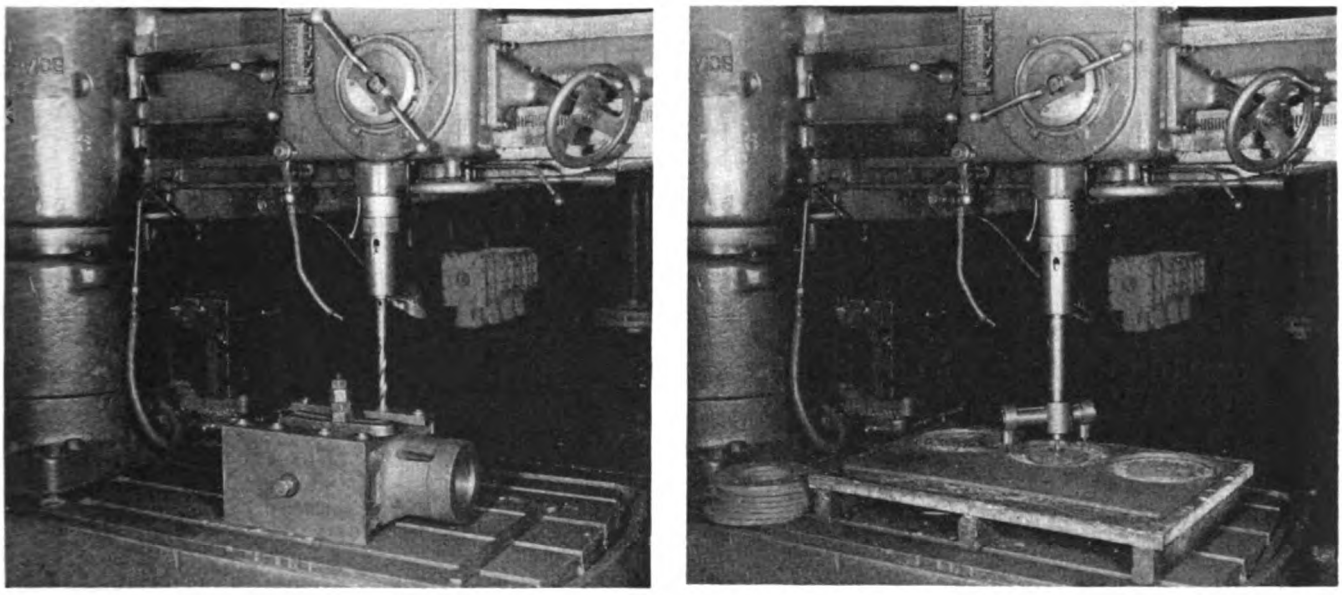
Lifting and putting in place a tire on a main driving-wheel center is simplified by the hook pick-up device.

* This is Part I of a two-part article. Part II will appear in an early issue.

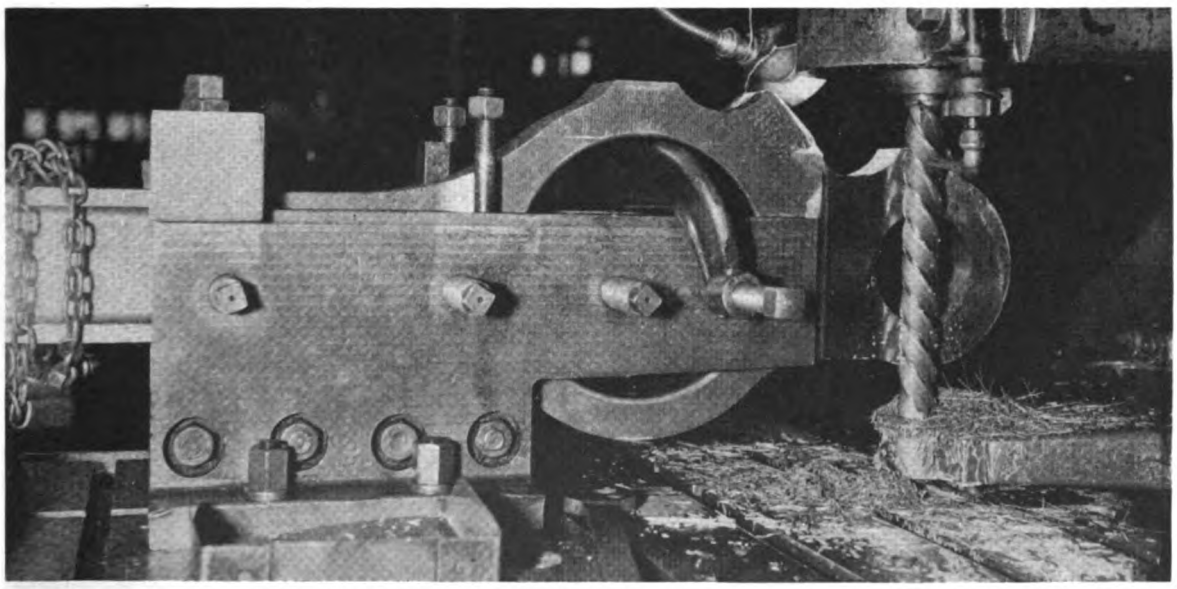
† Assistant shop engineer, Illinois Central.



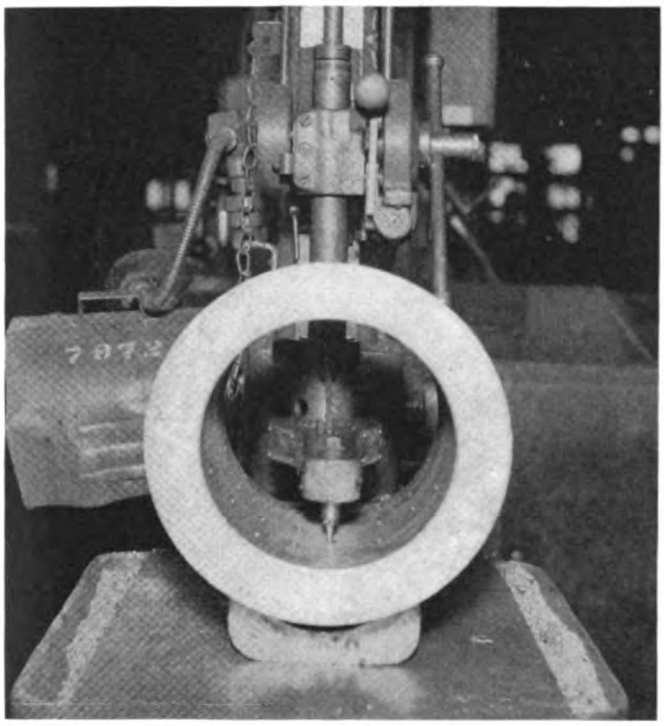
Device for holding main crank pins while drilling the center holes



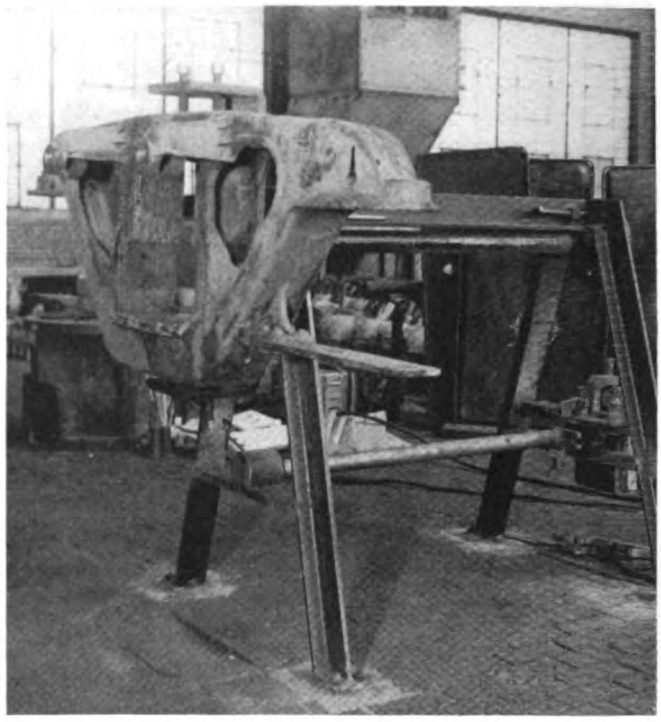
Left: Jig used in drilling main crosshead gib-bolt holes—Right: Tool for cutting fibre crosshead liners



Jig for holding side rods while clevising on a vertical milling machine

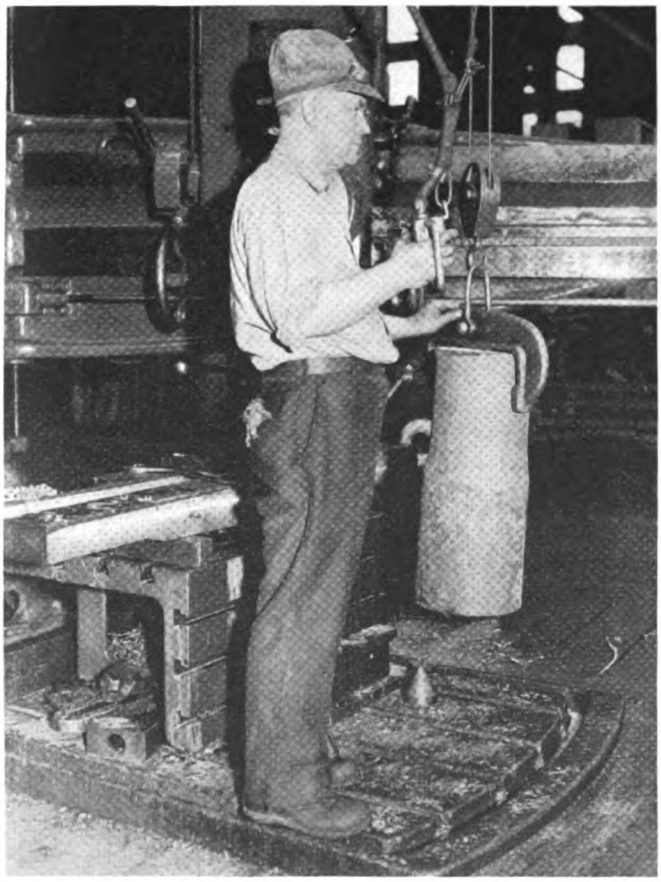


Drill extension device for countersinking rod-bushing grease holes on the inside



Universal welding jig for holding truck sides and truck boxes while welding

The hook is forged from steel, a lip on the holder extending about 1 in. in to the bore of the tire with an adjusting hand screw on the opposite side of the tire used for clamping fast to the tire. On the flange side the clamp does not extend down to the bore where it would interfere with placing the tire on the wheel center.



How the crank pin is handled to and from the drill jig

A control handle may be seen in the illustration. This is made of 1¼-in. pipe, for handling in place when the tire is hot. The link through which the lifting chain is placed works freely and is fastened to the clamp by a 1-in. pin with a key in the end. The tire is lifted by an overhead crane and this device obviates chains or other arrangements which are slower and more hazardous.

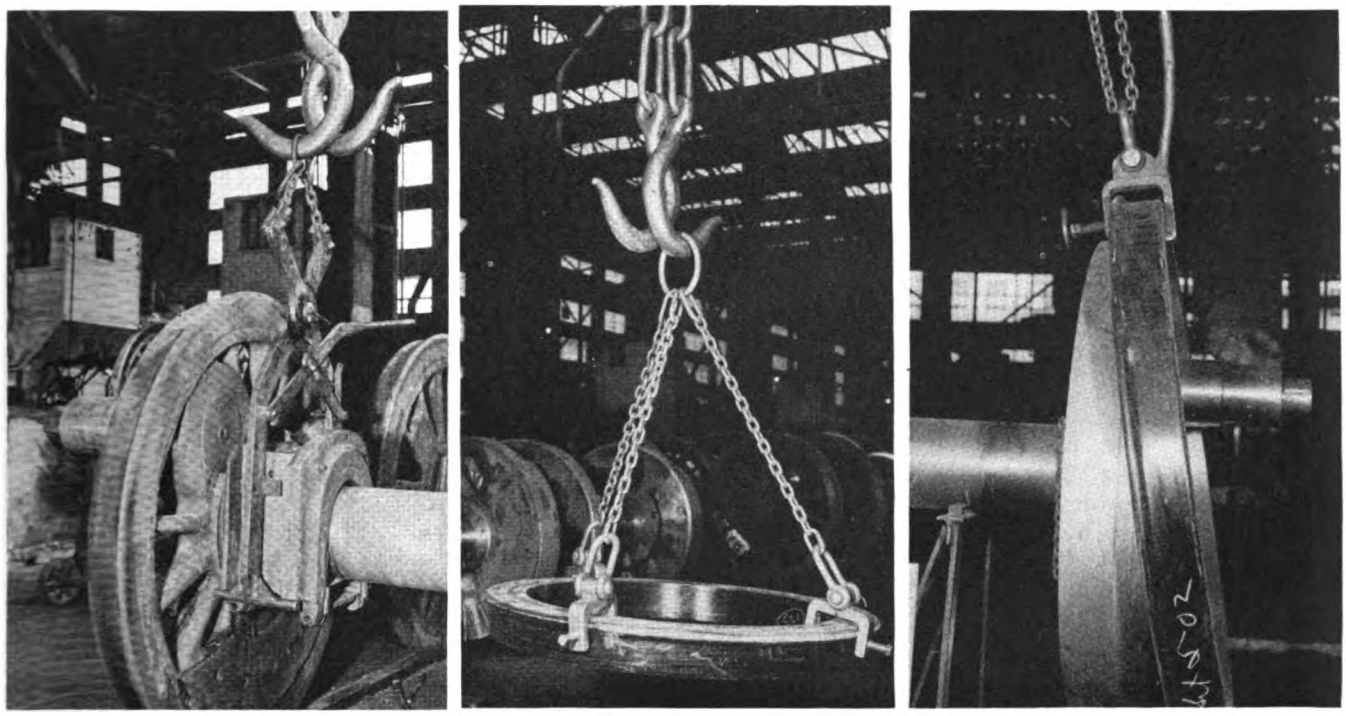
Handling a Driving-Wheel Tire

The three-jaw device, also illustrated, is used for lifting driving-wheel tires on and off a boring machine and for general handling of tires. The clamps are made of forged steel. No lip is used on this device. Set screws are used, but it is not ordinarily necessary to adjust the screws except in case of fastening to an unusually thin tire. Safety and speed are assured in placing this clevis device on and off the tire. The lift is, of course, made by an overhead traveling crane.

Lagging a Boiler

In applying lagging to a locomotive boiler, an adjusting platform is used. It consists of two pieces of 3-in. pipe for supports, each of which is set in a cast-iron base 20 in. in diameter; the base is bolted to a piece of flat iron ¾ in. by 20 in., which is 42 in. long and extends in towards the locomotive. The bases are tied together with two ¾-in. by 4-in. pieces of flat iron at the bottom along the floor. The tops are united by two tie rods 1 in. in diameter. The floor of the platform consists of a steel plate with 1-in. pipe serving as guards or hand railing around the platform. The platform itself is 120 in. long by 44 in. wide and strong enough to support a metal skid box filled with lagging, which is placed by an overhead traveling crane. The height of the platform is made adjustable by means of 1-in. holes in each of the two supporting pipes for a locking pin to conform to the level of the running board of the various type engines.

A ladder, made of 1-in. pipe, is fastened to the platform and supported near the bottom by a brace with a sleeve around the supporting pipe, so that the ladder



Left: Hooks for use in applying or removing locomotive driving boxes—Center: Three-point chain hook for handling driving tires—Right: Device used in applying driving tires to wheel centers

moves up and down as the platform is adjusted. Before the use of this adjustable lagging platform the lagging materials were carried in buckets by hand up to the running board, necessitating a great many trips before the job was finished.

Lifting a Driving Box

A device for removing or replacing driving boxes is shown in one of the illustrations. This is a hook arrangement made in tong fashion. It is adjustable, as may be seen, to various size boxes as they do not vary in size enough to exceed its adjustment range. A round T-rod arrangement of 1½-in. diameter hooks under the bottom of the box flange on each side of the box. An extension handle is provided for holding the hook open as it is placed over the box. Boxes are raised by use of this device with an overhead traveling crane.

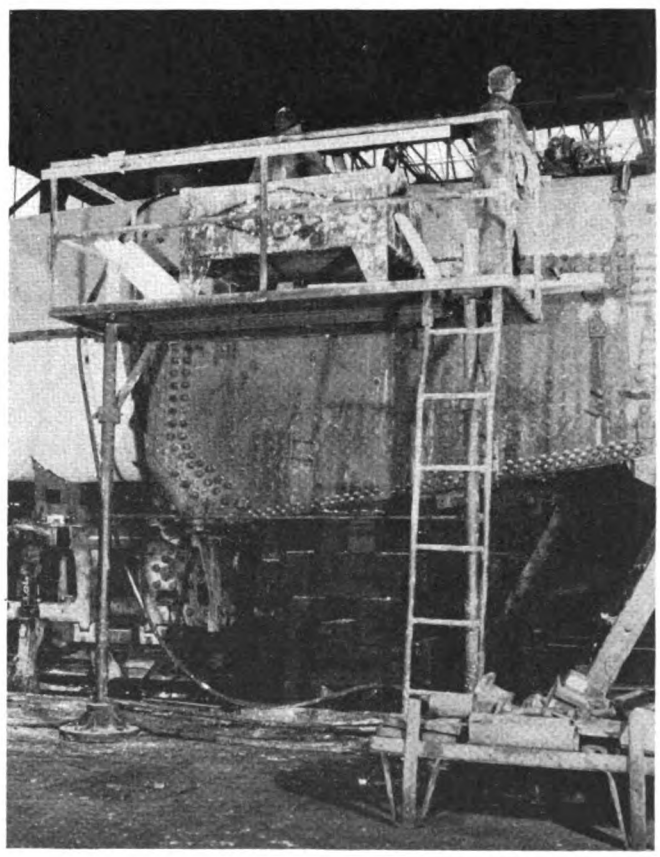
Holding Truck Sides and Boxes for Welding

Another device is a universal jig for holding tender-truck sides while building up worn places and for holding journal boxes while welding on liners. It is constructed as an A-frame from tee iron welded together and is 4½ ft. high. A shaft of 3-in. extra heavy tubing is used as a revolving member, on which a holding frame is welded. This is made of 1-in. by 12-in. wide flat iron. Two set screws, shown at the top in the illustration, are 1 in. in diameter and are used for clamping the truck side frame. The frame may be revolved to four positions and held in place by a pin and disc at the opposite end of the shaft.

On the same A-frame in the lower portion, there is a 2-in. piece of tubing on which is attached a clamp made in a similar fashion as that described above, but smaller, for holding an oil box in a handy position for welding. This can also be revolved to various positions.

Countersinking Grease Holes

On brass floating locomotive rod bushings, countersinking grease holes on the inside was a slow process until the lateral transmission device for driving the tool was perfected. It consists of a frame which attaches to a drill press spindle and which has two small sprockets one at the end where attachment is made to the spindle and the other at the end of the arm which reaches into the bushing. A light drive chain is used driving a small drill from the spindle through the housing. It is in a sense a bicycle chain and sprocket affair, with which



A safe and convenient platform for use in applying lagging

this operation can be performed in a remarkably short time as compared to former hand methods.

Holding Locomotive Rods On a Machine

A holding arrangement shown on the milling-machine table is used in properly holding forged steel side rods on the bed of a milling machine for clevising and tongue cutting. The device holds the rod accurately level and stable and eliminates all chattering of the rod while machining.

The two sides plates and base are made of forged steel and bolted to the machine table by four 1¼-in. bolts, two on each side. The plates are 2 in. in thickness having a filler block at the bottom, where four bolts are used for tying the two plates together at the base. The rod is held in the device by set screws which are 1½ in. in diameter. The block, shown on top of the rod, is of forged steel 2 in. by 4½ in. by 14 in. long, with lips extending over the two side plates and clamped down by two 1¼-in. bolts which serve as a clamp for holding the rod down.

In the photograph, which shows the milling of the tongue end of a rod, a C-clamp is used to hold the rod end firm. The same general clamping arrangement is used also when holding the rod for milling the clevis end. This arrangement holds rods in accurate alinement and obviates cutter breakage frequently encountered with a make-shift arrangement.

Failures of Diesel Engine Parts*

The latest analysis made of the principal origins of failure in accidents to insured Diesel engines shows the following relationship:

Name of part	Percentage of failures
Bearings	30.0
Cylinders (including heads and liners)	24.3
Pistons and piston rings	15.3
Valves	7.3
Crankshafts	4.5
Connecting rods and crankbolts	4.5
Gears	4.5
Fuel pumps and piping	2.8
Governor parts	2.8
Exhaust manifolds	2.3
Accidents not otherwise classified	1.7

These percentages vary slightly from year to year, but there has been a noticeable improvement in the experience with crankshaft, connecting-rod, and crankbolt breakage. This has been due to the breakdown-preventing inspections given insured equipment, and has, of course, been a factor in the most recent compilation of rates.

The highest percentage quoted is that of bearing failures. From an analysis of the loss history of bearings it seems quite significant that the high percentage of bearing failures is definitely connected with piston-scuffing and piston-seizure troubles, a fact which correlates bearing troubles and cooling practices.

The percentage of cylinder-head, cylinder, and liner losses is next and could be lowered appreciably by the installation of closed cooling systems and by the systematic practice of after-cooling every time the engine is stopped. The necessity of safeguarding the cylinder wall against undue localization of heat from the hot piston top at the time a Diesel engine is stopped is not sufficiently appreciated. Many engines always stop in approximately the same position. This may cause the formation of circumferential cracks in the cylinder wall at the point where a hot piston top has repeatedly come to rest. Numerous cases of circumferential cracks in cylinder liners could be traced directly to this cause, particularly where no after-cooling has been used.

As already mentioned, crankshaft breakage is being more effectively prevented nowadays by an improved crack-finding technique and the periodical dismantling of shafts. Whitewash tests give good results and the magnetic method of crack finding is employed where it may give some advantage over the whitewash test.

A very important factor in the improved crankshaft experience has been the use of the Hartford strain gage, developed by the company (Described in The Locomotive, April 1934, page 34). This instrument is placed between the crankwebs and gives a reading of the distortion of the cranks due to misalinement of bearings, improper foundation support of the engine base, the influence of overhung flywheels, or excessive belt tension. From such distortion readings the apparent fibre stress from the bending strains in the cranks can be determined.

Experience has taught that whenever a piston seizure has resulted in the engine being brought to a more or less abrupt stop, it is always advisable to replace the crankbolts of the affected cylinder because of the heavy over-stresses in the bolts caused when all the power in the engine is attempting vainly to continue the seizing piston in motion.

It seems appropriate to mention the company's experience with the repairing of broken shafts and the building up of shaft surfaces by fusion welding. Such repairs have not come up to expectations. Shafts that have been welded should receive dismantled inspections at frequent intervals.

The building up of shaft journals and flywheel seats on shafts has been particularly disappointing in that in so many cases cracks form in such built-up shafts and eventually lead to complete breakage. Such repairs have stood up only from a few months to two or three years.

* Excerpts from an address entitled "Diesel Engine Insurance and Experience" by H. J. Vander Eb, assistant chief engineer, Turbine and Engine Division, Hartford Steam Boiler Inspection and Insurance Company, published in that company's magazine The Locomotive, for January, 1940.

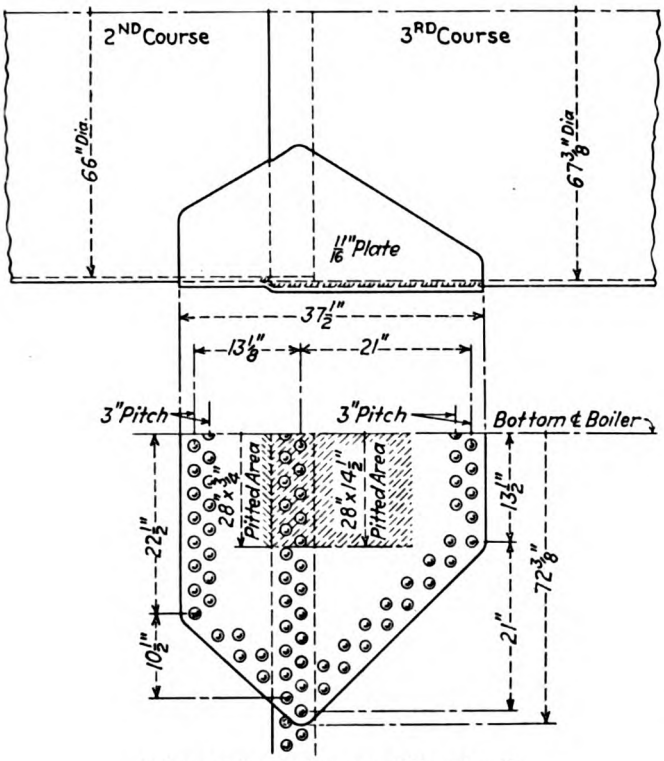
[NOTE—The data and comments in this paper undoubtedly refer to types of Diesel engines other than those common to the Diesel-electric locomotive. Irrespective of the engine type, however, the data, derived from experience, is of interest—EDITOR.]

Boiler Patch To Fit Offset Between Two Courses*

The defect in the boiler shell consisted of a pitted area at the back end of the second course, ¾ in. wide, extending 14⅜ in. into the third course with a width of 14 in. on either side of the bottom center line. A patch of $^{11}/_{16}$-in. boiler plate, 37½ in. by 72⅜ in., was designed to repair this defect.

The location of the patch made it necessary to roll the patch plate to two different radii and the following method was used with very good results. A rectangular plate from which the patch was to be formed was cut slightly larger than the size of the desired shape. Two other plates of the same thickness, one 14 in. by 75 in., and the other 22 in. by 75 in., were also cut. The patch plate was placed in the furnace to be heated and while it was heating one 75-in. edge of each of the smaller plates was bevelled to form a smooth, rounded surface. As soon as the patch plate was heated to the desired

* An entry in the prize competition on boiler patches, announced in the March, 1939, issue. The names of the winners were published in the August, 1939, issue.



Boiler patch rolled to two different radii

temperature, it was removed from the furnace and placed in the rolls. Inserting one of the smaller plates beneath and one above the patch plate, the patch was rolled to form two cylindrical surfaces with an offset between them to match the offset between the boiler courses.

When the plate was cold, the holes were laid out and drilled, and the plate was trimmed to the proper size and chipped. The patch was riveted to the shell, after which all rivets and seams were caulked.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Design of Dry Pipe in Boilers Without Steam Dome

Q.—On locomotives not equipped with a steam dome on top of the boiler, how is the steam taken into the throttle?—G. E. O.

A.—This boiler design, as developed by the Canadian Pacific, consists of eliminating the steam dome and the boot-leg at the end of the dry pipe. Multiple throttles are located in the smokebox. The dry pipe extends back from the front tube sheet to the third course (the boiler course of largest diameter) and is offset so that the top of the pipe is 2¾ in. below the inside of the third course. The end of the dry pipe is sealed by inserting a plate and seal welding all around.

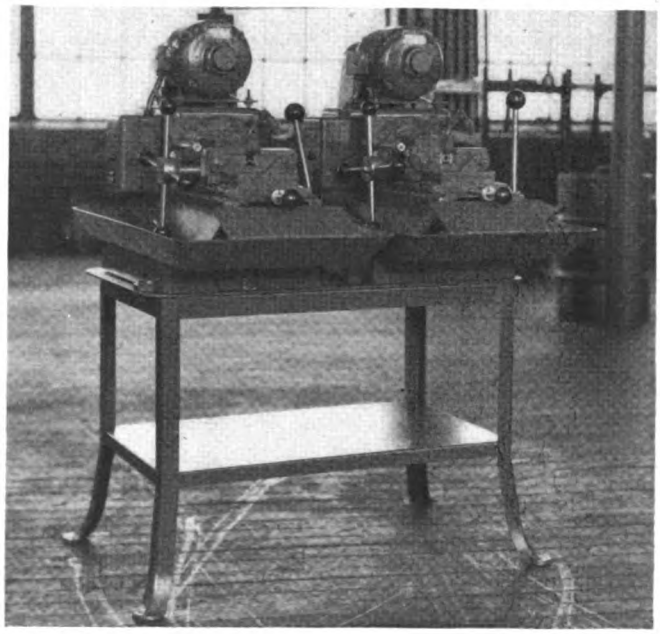
The steam is taken into the dry pipe through a series of slots in the top of the pipe, the slots starting about six inches from the end of the dry pipe. The slots run circumferentially with the pipe and are made 4 in. long ¾ in. wide with 1-in. bridges. The total area of the slots is approximately twice the area of the dry pipe.

The slotted portion of the pipe is enclosed at each end by erecting baffle plates 12 in. wide and extending them up to the inside of the shell. Deflecting plates, running parallel with the pipe, extend out from the ends of the slotted holes to the width of the baffle plates on both sides, the deflecting plates being spot welded to the baffles at each end. The effect of the baffle and deflecting plates is to spread the water-surface area over which the steam rises sufficiently to prevent the lifting of the water and to effect a much steadier level of the water in the water glass.

Double-Spindle Threading Machine

A double-spindle threading machine developed by the Geometric Tool Company, New Haven, Conn., is composed of two units, each of which may be operated independently of the other. This arrangement is said to be economical when the thread being cut is of sufficient length to allow the operator time to unload and chuck one work-holding device while the other unit is cutting. The machine is furnished in three sizes with a complete threading range from 1/16-in. to 1½-in. diameters, cutting National fine-thread pitches only in the larger diameters.

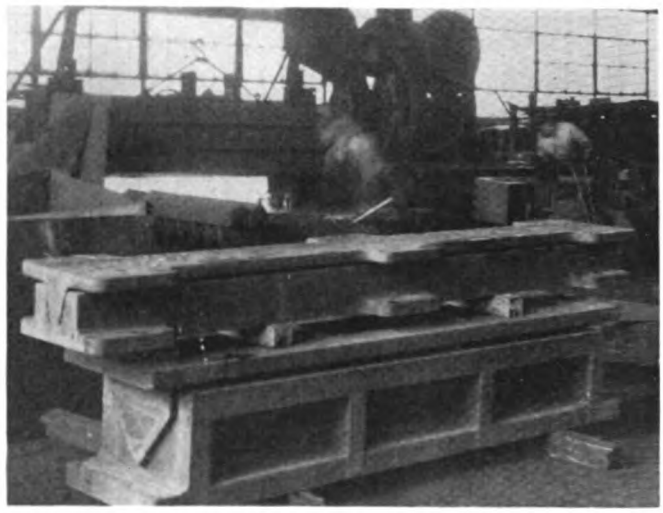
As the units are separate, one thread size may be cut in one unit and a different size in the other. The individual motors permits them to be run at the proper speed for the thread being cut. The cutting lubricant for each unit is supplied by an independent pump, and each is furnished with a chip pan. Either unit may be employed to cut right- or left-hand threads.



The double-spindle threading machine made by the Geometric Tool Company has two units which operate independently

Forming Steel Car Parts

At the Galesburg, Ill., steel car shop of the Chicago, Burlington & Quincy, two bulldozers are used with exceptionally good results in forming steel car parts of many different sizes and shapes. By the use of the proper dies, moreover, these machines are being used in making certain parts which it was formerly thought could be formed successfully only under hydraulic presses of large size. The larger bulldozer, a Williams & White No. 29 machine with a main header 9 ft. long by 37 in. high, is equipped to make large pressings with dies which actually extend a limited distance above the top face of the header. The dies usually consist of Grade B cast iron, made at West Burlington shops, although some built-up dies are fabricated by welding at Galesburg shop. The production of car parts is usually





Above: Cast-iron dies used in the No. 29 bulldozer for making crossbearer diaphragms — Left: Fabricated steel dies used in making the bottom angle of hopper-car center partitions — Below: Special dies, large furnace and No. 29 bulldozer at the Galesburg steel car shop of the C. B. & Q.

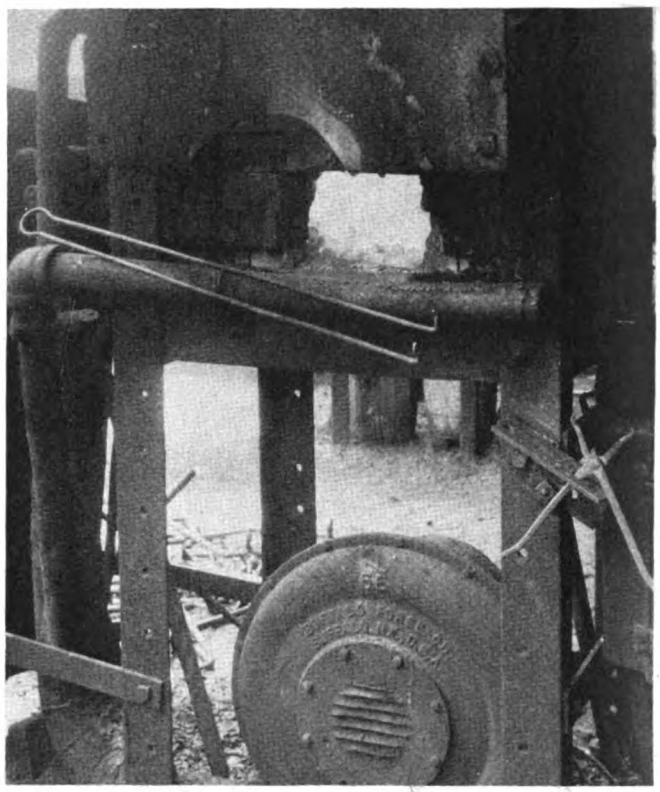


higher than that obtained with hydraulic presses owing to the more rapid power stroke of the bulldozer.

Two pairs of dies are shown in the foreground of the upper illustration. The furnace for heating steel sheets is shown in the left background and the No. 29 bulldozer at the right. The upper pair of dies is used for forming side stakes and the lower dies for longitudinal hood sheets used in steel hopper-car construction.

The fabricated steel dies used in making the bottom angle of the center partition for cement hopper cars are cut out on the Oxygraph gas-cutting machine to the shape indicated and have reinforced plates applied by welding. The male die is illustrated at the left on steel horses and the female die is shown at the right on the ground. These dies are 9 ft. 4 in. long by 15 in. wide and the shelf consists of old arch bars, joined by welding to form a 4-in. by 4½-in. cross section. The dies are used in the No. 29 bulldozer and the piece is formed hot in one operation of the bulldozer.

In making the crossbearer diaphragm the dies shown in the background of the middle illustration are used in the No. 29 bulldozer. These crossbearer diaphragms are made of $\frac{5}{16}$-in. sheet steel and are 50⅞ in. long by $35\frac{13}{16}$ in. high. The female die, shown next to the diaphragm, is a combination right and left die, cast in one piece and machined to the shape indicated with a center slot in the left end through which the completed diaphragm may be released from the die. Right or left male dies are required, depending upon which diaphragm is desired. With the dies properly and rigidly fixed in the bulldozer, a hot sheet previously cut to the desired shape by stack flame cutting in an Oxygraph machine is removed from the furnace, correctly positioned against the female die which is bolted to the stationary bolster, and the diaphragm is pressed hot in one operation by a single stroke of the male die which is rigidly bolted to the header ram. On the return stroke, a small bar inserted between the pressing and the stationary die serves to strip the diaphragm from the movable die and it can be readily removed through the slot provided for that purpose in the side of the stationary die.



Rivet-heating furnace and special tongs used in handling rivets

Air Screen Protects Rivet Heater

Two different types of tongs, commonly used in connection with riveting work at railway steel car shops, are shown in the illustration. The long rivet tongs are used for removing hot rivets from the furnace and also, when necessary, for throwing rivets a short distance to the riveting position, whether at ground level or on the overhead structure of an adjacent car. The riveter's helper then uses the short "sticking" tongs, shown at the right in the illustration, to place each rivet in the desired hole ready for riveting.

Both of these tongs may be used for the easy handling of rivets with one-hand operation. The feature of the long tongs is that they are made of a brake-cylinder coil spring, heated, stretched out to the required length for 36-in. tongs, and having the ends forged and bent, as shown in the illustration, to fit around a rivet. Being made of spring steel, these tongs require no heat treatment and have just enough spring to be easily used in handling rivets with one hand.

Incidentally, the type of rivet-heating furnace illustrated, utilizes a highly effective method of protecting the operator from the heat of the furnace. It will be noticed that a steel baffle plate is set out about 4 in. from the face of the furnace wall, just even with the top of the door, and a 2-in. perforated air pipe, just under the door, directs a blast of air upward along the exterior furnace wall with sufficient force to entrain the hot furnace gases and direct them upward between the furnace wall and the baffle plate. This construction gives almost complete protection to the operator from hot air and gases and leaves him exposed to only a relatively small amount of radiant heat from the furnace.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Repairs Permissible After Extended Period

On June 18, 1936, a St. Louis-East St. Louis information card was issued by a car inspector of the New York, Chicago & St. Louis against the Mobile & Ohio on St. Louis-San Francisco car 127154. The defects enumerated were "two metal center sills bent in excess of 2½ in. between body bolsters, A end." On February 24, 1937, the St. Louis-San Francisco sent this information card to the M. & O. with the request that in accordance with A.A.R. Rule 4, paragraph 1, statement be furnished showing how damage occurred or, if unable to do so or if damage occurred in unfair usage, to furnish defect card. On April 13, 1937, the M. & O. forwarded to the St. L.-S.F. a defect card covering the defects. In May, 1937, bill the St. L.-S.F. rendered a charge of $496.46 for repairs made to this car at its Springfield,

Mo., shop on authority of M. & O. defect card. The M. & O. took exception to the charge, contending that it was excessive and that the extent of repairs was no doubt due to the car remaining in service over a period of several months with the sills bent, during which it had made 23 interchange and 26 line movements. Due to its inability to show the circumstances of the damage and upon the assumption that the information card had been issued in accordance with A.A.R. rules and the rules of the St. Louis-East St. Louis Superintendent's Association, the defect card was issued. In the opinion of the M. & O., subsequent investigation revealed that the defect card had been erroneously issued. The St. L.-S.F. stated that if there was any question regarding the validity of the information card, the M. & O. should have settled it prior to issuing the defect card and the rules provide that defect cards cannot be repudiated. It contended that the period of time between the issuance of the information card and the date the car was repaired had no bearing upon the responsibility for damage to the car and that there was no evidence that the sills were further damaged between the date the information card was issued and the date the car was repaired. It stated that the defects were impossible to repair without dismantling the affected parts and, in this instance, some of the affected parts of the center-sill assembly could not be straightened and reused. All other parts charged for were removed, replaced, or renewed to gain access to the damaged parts covered by the defect card.

In a decision rendered November 16, 1939, the Arbitration Committee stated: "The road causing the damage had the option of making repairs instead of delegating the work by the defect card. Rule 5 prescribes the period within which the carded defects must be repaired after the car reaches the home line to justify the bill. A defect card issued under the circumstances has the same status as any other defect card. The contention of the car owner is sustained."—*Case No. 1772, Mobile & Ohio versus St. Louis-San Francisco.*

Axle Not Condemnable—May Not Be Changed at Owner's Expense

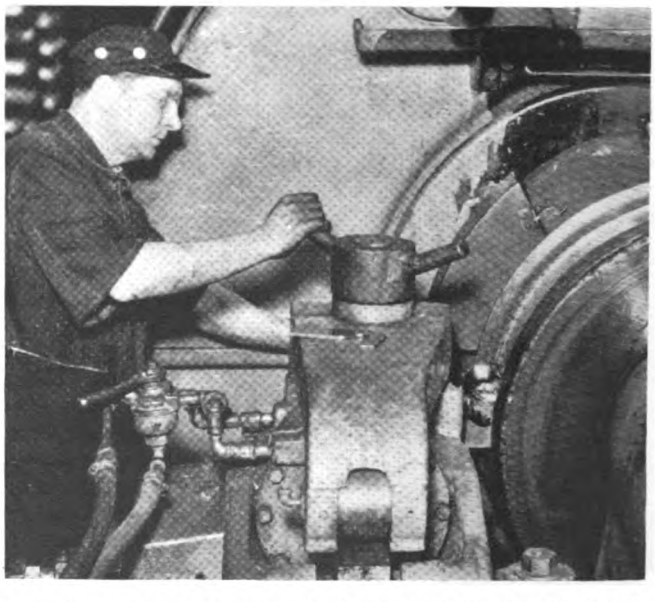
On December 30, 1937, St. Louis-San Francisco car 130112 was repaired at Peoria, Ill., by the Toledo, Peoria & Western. The repairs consisted of applying two second-hand cast-steel wheels on a second-hand axle, two new journal bearings, four new box bolts and four new nut locks. The primary reason for making repairs was a defective L-3 journal. The billing repair card of the T. P. & W. in the "why made" column showed "journal damaged by flange of other wheels. Will true." Under "repairs made" column, in addition to a list of the repairs, was a notation "journal has several deep dents indicating journal had been applied to the car in this condition." A charge was rendered against the St. L.-S.F. for differences in value between one second-hand and one scrap wheel and for the value of new parts applied as previously listed. The St. L.-S.F. took exception to the charge, contending that this defect was a handling-line responsibility while the T. P. & W. contended that this defect was the owner's responsibility. In its statement the St. L.-S.F. listed the interchange movements of this car between December 22 and December 29. They contended that if the journal was cut or damaged or showed signs of heating when received from the connection, the T. P. & W. should have protected itself in interchange. The St. L.-S.F. stated that its records did not indicate when these wheels were applied but they had apparently been under this car for several years and if the defect on the journal was caused prior to the application of the wheels, as claimed by the T. P. & W., trouble would have been experienced immediately after application. The T. P. & W. stated that the three indentions in the journal varied from 1/16 in. to ⅛ in. deep by ½ in. wide to 1 in. long. There were no indications on the brass or journal of overheating or damage caused by overheating, but this road decided that inasmuch as this journal was actually cutting the brass, it was unsafe for movement in a train and the proper procedure was to change the wheels. Since the journal did not show any signs of heating, it could not request the delivering line to furnish defect cards and as they felt the journal was unfit for service in this condition, the wheels were removed.

In a decision rendered November 16, 1939, the Arbitration Committee stated: "As the journal had given no trouble and the axle otherwise was not condemnable under Rules 84, 85 or 86, the Toledo, Peoria and Western may not change the axle at the expense of the car owner. A charge, however, is proper against the St. Louis-San Francisco for journal bearing condemnable under Rule 66."—*Case No. 1773 St. Louis-San Francisco versus Toledo, Peoria & Western.*

Bethlehem Develops High-Carbon Tool Steel

A new tool steel, marketed under the name of Red Tiger, has recently been developed by the Bethlehem Steel Company, Bethlehem, Pa. It is a special high-carbon, high-vanadium tool steel suitable for a wide variety of uses ranging from heavy hogging cuts to fine finishing operations. This steel represents a departure from standard practice as the carbon content has been markedly increased to produce extra hardness, averaging from 65C to 68C Rockwell, attained without producing excessive brittleness. The impact properties of this steel, as shown by physical tests, are approximately the same as those of standard carbon 18:4:1 high-speed steel.

Its fine shock-resisting properties permit this steel to be used on intermittent cuts without danger of breakage.



Taking heavy cut on 30-in. car wheel using Red Tiger tool steel made by Bethlehem Steel Company

Due to its high carbon content, it also is adaptable to fine finishing operations, producing a surface comparable with that obtained when using the old type of finishing steel which could only be employed in low-speed cutting. Good red hardness values allow it to take heavy hogging cuts.

The analysis of Red Tiger tool steel is approximately as follows: tungsten, 18 per cent; chromium, 4 per cent; vanadium, 2.5 per cent; molybdenum, .60 to .80 per cent, and carbon, 1 per cent. Standard heat treatment is used without any extra precautions. The following treatment is recommended: Preheat the steel slowly to between 1,500 and 1,650 deg. F. and soak thoroughly. Transfer to the hardening furnace, heat rapidly to between 2,350 and 2,375 deg. F., and oil quench immediately to about 200 deg. F. Allow it to cool to room temperature, charge into a tempering furnace and draw to 1,050 deg. F. If followed properly, this procedure will give a Rockwell hardness between 65C and 68C.

The principal applications of this tool steel is in making roughing and finishing cuts for all general purposes and for machining materials such as heat-treated railroad car wheels and axles, cast iron, and heat-treated alloy steel. In machining heat-treated car wheels, a speed of 16 ft. per minute has been used with a $\frac{7}{16}$-in. depth of cut and a $\frac{7}{16}$-in. feed. It is supplied as bar stock, heat-treated tool bits (furnished in a ground condition only), and turning plugs used with special tool holders.

Welding Positioner

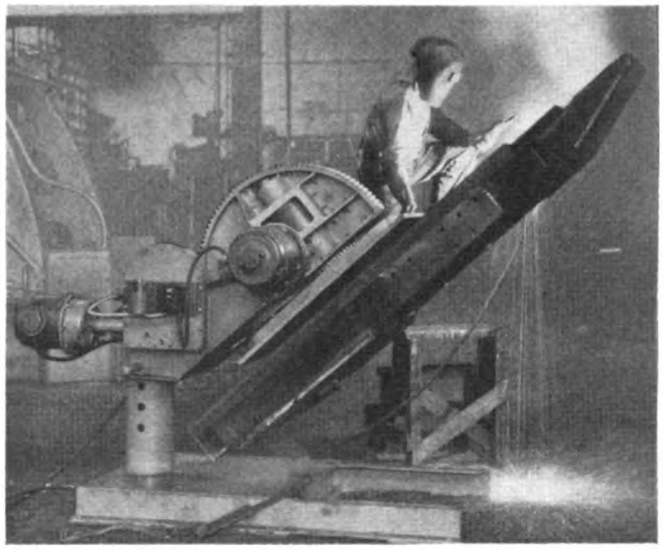
The Cullen-Friestedt Company, Chicago, manufacturer of car pullers, has recently developed and placed on the market a tool of primary interest in the welding field because it enables positioned welds to be made quickly, economically and with maximum safety for the welding operators. The C-F welding positioner consists of a substantial base plate and vertical post on which is mounted a table capable of being revolved in either a horizontal or a vertical plane. The maximum vertical angular movement is 135 deg., or 45 deg. beyond the vertical and the table can be rotated through a full circle regardless of the angle at which it is tilted. This combination makes it possible to position all welds properly for down-hand welding without rehandling the work.

Tilting and rotating movements of the table are independently controlled. On hand-operated machines, tilting and rotating movements are each operated by independent hand wheels through self-locking gearing. Power-operated positioners are driven by independent motors, also self-locking, for tilting and rotating.

The mechanism for rotating the table can be disengaged (on hand-operated machines only) so a balanced or circular job can be easily rotated by the welder, from any position, without using the hand wheel. The height of the table is adjustable to various positions as required and for large jobs a standard positioner can be mounted on a table to give additional height. The table is removable so special fixtures can be attached to the head.

The C-F welding positioners are available in three sizes to accommodate work weighing 2,500 lb., 6,000 lb., and 14,000 lb., respectively. The 2,000-lb. machine can be furnished for hand operation or equipped with power for tilting or rotating, or both. Constant-speed rotation or variable-speed rotation is optional. The two larger machines are fully powered for tilting and rotating.

While this type of welding positioner is adaptable for use in fabricating locomotive pilots, air-pump brackets, gas-engine heads, etc., its primary adaptation in the railway field is for the fabrication of such car parts as truck or body bolsters, underframe sub-assemblies, end frame sections, welded truck side frames and any number of similar details which are made primarily of structural-steel plates joined in a unit structure by welding.



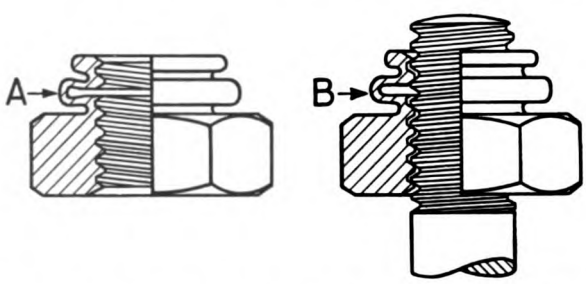
Typical welding job on a Cullen-Friestedt power-operated welding positioner

Effective One-Piece Self-Locking Nut

The Boots self-locking nut is an all-metal nut designed to withstand the most severe vibration. It is essentially two nuts in one with the top section displaced downward so that the upper (locking) threads are out of lead with respect to the load-carrying threads of the lower section. The two sections are connected by a spring member which is an integral part of the nut. Upon the insertion of the bolt, the spring member allows the top section of the nut to be extended to permit its proper engagement with the threads of the bolt. A force is thus established which firmly grips the nut without damage to the threads of the bolt and accommodates all thread variations.

In the diagram, *A* shows the spring member in its displaced position when not engaged with a screw or bolt. The position of the spring member, when the nut is engaged, is shown at *B*. Both diagrams are exaggerated to show the principles involved.

These nuts are made with standard threads and at present are available in sizes from No. 8 to ¾ in. in a variety of metals. Additional sizes and types are under development. They are produced and distributed by the Scovill Manufacturing Company, Waterbury, Conn.



The Boots self-locking nut made by the Scovill Manufacturing Company

THE READER'S PAGE

Diesel versus Steam

To the Editor:

I am interested in the discussions on Diesel-electric locomotives appearing in the *Railway Mechanical Engineer*. It would seem that the efficiency of the Diesel is being judged more from a thermal and mechanical standpoint when comparing it with the steam locomotive. The ultimate efficiency of any prime mover is its ability to perform a given job with the lowest outlay of money. In this respect the modern steam locomotive ranks high. In the matter of fuel economy, the Diesel is undoubtedly way ahead of the steam locomotive, but when one takes into consideration that the first cost of the Diesel is about three times as much as a steam locomotive of like power, it would seem that the fixed charges on the higher priced Diesel will nearly nullify this advantage. Fuel prices vary over 100 per cent in different parts of the country for steam locomotives and Diesel fuel will no doubt continue to rise with increasing demand, so that the Diesel's greatest advantage is subject to quite a variation in different localities.

As to availability, there are modern 4-8-4 type engines which have an availability of 93.4 per cent, and have shown a return in one year of over 50 per cent on the investment. Train schedules usually determine the monthly mileage that these modern units can make.

One of the claims for the Diesel is that it can be utilized nearly 24 hours a day without going to the enginehouse for servicing. Facilities can be provided at moderate cost, whereby the steam switcher can be serviced to stay out until due for a washout.

It would seem that a thorough analysis of conditions in each individual case is necessary, remembering that what may be successful on one road will not necessarily be so on another.

A Reader

Unit Pressures Allowable On Oil-Lubricated Bearings

To the Editor:

In the February issue of the *Railway Mechanical Engineer* E. C. Pearce has an article dealing with the subject "Journal Box Temperature." I presume he is using one box and one 5½-in. by 10-in. journal as the waste, and oil, would be about right for one box, and yet he states that the weight, or load, used was 20,000 lb. which according to his figures, was 890 lb. per sq. in. of actual bearing surface. The 20,000 lb. per journal, and I judge that means 40,000 lb. per axle, seems about the nominal capacity for such axles, but it has always been my belief that when you loaded a standard journal bearing in excess of 400 lb. per sq. in. you were reaching the limit at a speed of 50 m. p. h. as the oil film would break down.

W. C. Fox

[The unit pressure of 890 lb. per sq. in. was given as the unit load on each square inch of projected actual bearing area. If the 20,000-lb. load was distributed over the projected area of the entire surface of a 5½-in. by 10-in. journal, the unit pressure would be reduced to about 364 lb. per sq. in., but would include an area which is not fully effective for load-carrying purposes. This is the basis on which unit bearing pressures are usually calculated and on which they are rated.—*Editor*]

Preventing Boiler Explosions Due to Low Water

To the Editor:

I have read the editorial entitled "Boiler Explosions" in your February, 1940, *Railway Mechanical Engineer* with much interest. This editorial is very well prepared and I am glad to note that you are interested in the prevention of boiler explosions.

From your analysis, you assume that the last three years' experience implies that an irreducible minimum of boiler explosions caused by crown-sheet failures due to lower water in which no contributing causes or defects are found has been reached at about four or five per year.

Accidents of this kind are, as you state, an exceedingly old story; and while, as you mention, a minimum of four or five per year in operations involving over 40,000 locomotives scattered over the United States might be considered as highly satisfactory, provided there were no preventative.

The Southern Pacific Lines have now completed eight years of operation of steam locomotives protected by the multiple application of boiler drop plugs, and notwithstanding that we have experienced during this period 123 cases of low water, we have not experienced a single case where a boiler drop plug failed to function and give the necessary protection; neither have we had a boiler explosion or a burnt crown sheet or serious damage to a locomotive boiler due to low water.

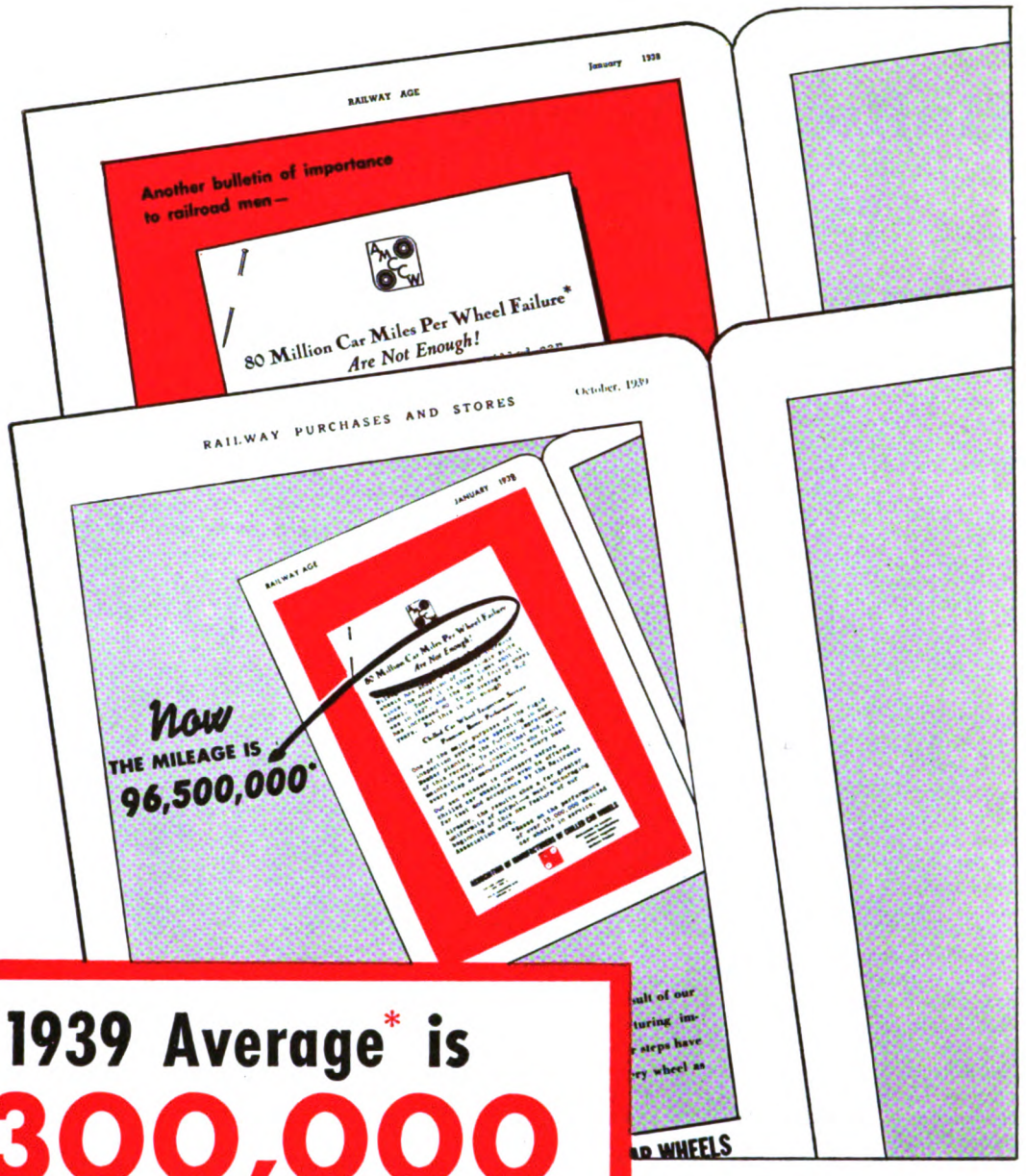
Our eighth annual report, under the heading "Boiler Drop Plugs—Record of Application and Performance," shows that on the Pacific System, covered by this tabulation, the minimum number of cases of low water in any one year was seven, while the maximum was 33. It is also interesting to notice that the responsibility for low water is very evenly divided between engine crews and yard and roundhouse forces. In this connection, an analysis shows that in 76.4 per cent of the cases where low water was experienced, the only repairs necessary to put the engine back into service was to renew the drop plugs.

We have gone a little farther back in our summary of boiler explosions due to lower water, as reported by the Bureau of Locomotive Inspection, and a summary of boiler explosions resulting from crown-sheet failures during the past eight years shows an average of seven boiler explosions per year with an average of 9.1 persons killed and 15.8 persons injured. This represents 62.9 per cent of the total fatalities from locomotive operation.

I feel that our eight years' experience with the use of boiler drop plugs proves quite conclusively that boiler explosions caused by crown-sheet failures due to low water can be prevented.

Frank E. Russell,
Mechanical Engineer, Southern Pacific.

(*Turn to next left-hand page*)



The 1939 Average* is 117,300,000 Car Miles per Wheel Failure

*Average still based on performance of over 15,000,000 wheels in service.

A 20% better record for 1939 shows how rapidly improvements effected in manufacturing are reflected in performance.

ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS

230 PARK AVENUE,
NEW YORK, N. Y.

445 N. SACRAMENTO BLVD.,
CHICAGO, ILL.

AMCCW

ORGANIZED TO ACHIEVE:
Uniform Specifications
Uniform Inspection
Uniform Product

High Spots in

Railway Affairs . . .

Sold Down the River!

The Transportation Bill of 1940 (S. 2009) was given most painstaking consideration over a period of a year and a half in the House and the Senate, and by the conferees. It is doubtful if any single piece of legislation has received more thorough discussion and study by Congress. It was all set for final passage and to be sent to the President for approval; indeed, it looked as if these processes would be almost automatic and that within a few days the bill would be enacted. To the surprise and consternation of members of Congress and friends of the railroads, a totally unexpected brazen foray or blitzkrieg was made upon it, as the result of which it was recommitted, apparently to suffer an ignominious decease. Who is responsible for this outrageous procedure? Surely not a friend of the workers on the railroads, or of the investors in railroad securities. Certainly not the managers, who have been fighting with their backs to the wall to put the properties back on their feet. Who, then, is responsible? Apparently the leaders of the five transportation brotherhoods, together with certain large businesses which ship extensively by inland waterways and principally at the expense of the taxpayers of the United States. It is well known that the public does not profit by such shipments, since the difference between the costs of shipping by water and by rail is pocketed by the shippers. Just what sort of bargain was made by the brotherhood leaders is not known. Presumably they were promised some assistance in enacting legislation in the future to promote such things as train limit, full crew and other "make work" bills.

Misleadership

We do not believe that any large proportion of the members of the transportation brotherhoods are sympathetic with the action taken by their leaders in sabotaging S. 2009. When this traitorous action was taken, the leaders of the 13 other railroad brotherhoods, which represent over 75 per cent of the railroad employees, immediately took steps to do everything they could to offset the steps taken by the five brotherhood leaders. We salute them for their courage and good sense. At the same time we urge the members of the transportation brotherhoods to call their leaders to account. Incidentally, it would appear that these leaders—as they have studied the reaction—are very much worried over the action that they took. It is quite apparent, also, that the transportation committees of Congress are pretty well fed up on the barrage to which they have been subjected by the high pressure groups. They are disgusted too with the action of the brotherhood leaders and are not inclined to take further steps at this session unless pressure is brought on them.

Eastman's Advice to Railroad Employees

One of the snags that did much to slow up progress in transportation legislation in Congress, was the fact that one of the labor organizations insisted that there be no consolidation or unification of the railroads which would result in unemployment or displacement of any carrier employees. In an address which Chairman Eastman of the I. C. C. made before the Western Railway Club on May 20, he pointed out that, "It is clearly unsound and contrary to the best interests of the country to compel wasteful work to be performed, anyhow, or anywhere, at any time, and it is particularly perilous to all concerned, including the employees, to apply such doctrine to the railroads under present conditions. It is like putting lead in the saddle of a race horse. The railroads are in a race with their competitors. They have already lost a tremendous amount of traffic, and to the extent that they are handicapped by the weight of useless labor they will lose more or fail to regain what they might otherwise recover. No fiat of law can prevent the shrinkage of operations which results from loss of business or the reduction in employment which is the natural consequence of such shrinkage, and the railroad employees have had ample reason to know that this is so. So far as expansion of employment is concerned, they have, in my judgment, more to hope for in the long run from an increase in the economy and efficiency of railroad operations than from any other one factor, with the exception of a general increase in the business and prosperity of the country as a whole."

Vacations with Pay

The standard railroad labor organizations, through the Railway Labor Executives' Association, have started a drive to secure vacations with pay for their members. The conditions of employment in the various brotherhoods differ so greatly that two proposals are being worked out, one by the five transportation brotherhoods—the engineers, firemen and enginemen, conductors, trainmen and switchmen —and the other by 14 of the other unions. The train dispatchers are not participating because they already have vacations with pay. It is significant that "Labor," in announcing this new drive, precedes it with a bold type announcement to the effect that rail legislation is not dead in Congress; it is simply slowed up, so it says, because Senator Burton K. Wheeler, chairman of the Senate Committee, is attending to his political fences in Montana, while Congressman Lea is trying to clean up a heavy accumulation of business which was piled up because of the great amount of attention that he was forced to give to S. 2009 and the conferences concerned with it. Labor, in its issue of May 21, optimistically estimated that the decks would be cleared up within a week or 10 days, for further action on S. 2009 by the conferees.

Eastman's Subsidy Report

The long-awaited report of the former Federal Co-ordinator of Transportation on government aids to the various forms of common carrier transportation was finally made public on April 15. It comes to the somewhat astonishing conclusion that in 1936 only about $8,000,000 of government aid was given to motor vehicle transportation, as compared to $21,453,000 to air transportation, $35,635,000 to the railroads and $128,528,000 to water transportation. The "nigger in the woodpile" lies in the fact that a formula was used which, in effect, assigned about 60 per cent of the highway costs to the general taxpayer and only about 40 per cent to the users of the highways—of which, of course, the common carriers using the highways for intercity traffic are only a part, so that still other assumptions had to be made as to the distribution of the 40 per cent between the various classes of motor vehicles. Incidentally, the $35,635,000 assigned to the railroads includes an item of $26,000,000 calculated on the basis of savings in interest and other financial charges which would have been involved in borrowing money in the regular money markets, rather than from the R. F. C. and the P. W. A. Quite naturally the railroads disagreed emphatically with Mr. Eastman's findings. J. J. Pelley, president of the A. A. R., in appearing before the Temporary Economic Committee, pointed out that the railroads actually contributed more than $35,000,000 a year to the construction and maintenance of highways, through the payment of taxes on their property, and this, in fact, is only a small part of the contribution that they make to public welfare through the payment of taxes. Moreover, he said that "the taxes collected from these motor trucking companies are small, indeed, compared with the burdens which their operations impose upon the highways and others who use them." Apparently Mr. Eastman has stirred up a real hornet's nest.

(*Turn to next left-hand page*)

Only

MODERN POWER



can meet today's demands

Today's demands call for heavier loads hauled at higher speeds. Typical examples of "Modern Power" are the twelve 2-8-8-4 type locomotives recently delivered by Lima to the Southern Pacific.

These locomotives, used in high-speed passenger and freight service in mountainous territory, are proving themselves to be the economical answer to the problem of heavy loads hauled at high speeds.

LIMA LOCOMOTIVE WORKS, INCORPORATED, LIMA, OHIO

Among the Clubs and Associations

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The semi-annual meeting of the American Society of Mechanical Engineers will be held at the Hotel Pfister, Milwaukee, Wis., June 17, 18 and 19. That part of the program of particular interest to the railroad membership is as follows:

Monday, June 17

MORNING

Education and Training

Encouragement of Creative Ability, by John E. Ryan, and A. R. Stevenson, Jr., General Electric Company

The Employer Suggests Needed Improvements in Our System of Technical Education, by W. H. Carrier, chairman of the board, Carrier Corporation

Selection of Men with Creative Ability, by Alexander Magoun, Massachusetts Institute of Technology

Thursday, June 20

MORNING

Railroad Symposium

Steam Locomotives—Notes on Their Ages and Proportions, with Suggestions for Improvements, by J. L. Ryan, St. Louis-San Francisco

Notes on the Trends in Reciprocating Valve Mechanisms Employing Piston Valves, by Chas. F. Krauss, assistant chief engineer, Baldwin Locomotive Works

Notes on Valve and Valve Motion Design for Modern High-Speed Passenger Steam Locomotives, by A. G. Hoppe, assistant mechanical engineer, Chicago, Milwaukee, St. Paul & Pacific

Notes on the Measurement of Cylinder Power of High-Speed Passenger Locomotives—Apparatus and Methods, by L. K. Botteron, engineer of road tests, Union Pacific

Train Acceleration and Braking, by R. Clark Jones, Research Laboratory of Physics, Harvard University (To be presented by title).

WESTERN RAILWAY CLUB.—The following officers were elected at the annual meeting and dinner at Chicago on May 20: President, O. N. Harstad, general manager of the Chicago, Milwaukee, St. Paul & Pacific; first vice-president, W. W. Kelly, general purchasing agent of the Atchison, Topeka & Santa Fe; second vice-president, C. M. House, superintendent of motive power and equipment of the Alton; treasurer, J. W. Fogg, vice-president and general manager of the MacLean-Fogg Lock Nut Company, and executive secretary, W. L. Fox, general superintendent of the Belt Railway of Chicago.

A. A. R. MECHANICAL DIVISION.—The eighteenth annual meeting of the Association of American Railroads, Mechanical Division, will be held in the South Ballroom of the Stevens Hotel, Chicago, on Thursday and Friday, June 27 and 28. The meeting will convene at 9:00 a. m. each day and will adjourn at 5:00 p. m. on June 27 and as soon as the program is completed on June 28. Members are urged to be in their seats promptly at 9:00 a. m.

Extract from Section 10 (a) of the Mechanical Division, Rules of Order: "It shall also be the duty of the Committee on Subjects to receive from members questions for discussion during the time set apart for that purpose. That committee shall determine whether such questions are suitable ones for discussion and, if so, shall report them to the Division."

The Committee on Subjects will be appointed by the chairman at the opening session on Thursday, June 27, to receive from members questions for discussion. This Committee on Subjects will determine whether such questions are suitable ones for discussion and, if so, will report them to the Division at an appropriate time for discussion by the members. Members are requested not to start discussion on subjects at the sessions of the meeting which have not been first referred to the Committee on Subjects.

Members should be sure to register each day as they enter the meeting. There will be no badges used. Committee reports shall be limited in their presentation to a brief summary of their principal features. By presenting papers and reports as briefly as possible the maximum of time will be available for discussion. The members are urged to study carefully the advance copies of reports and papers and to be prepared to discuss them intelligently.

ANNUAL MEETING PROGRAM

Thursday, June 27

Address by C. H. Buford, vice-president, Operations and Maintenance department, Association of American Railroads

Address by Chairman F. W. Hankins, assistant vice-president and chief of motive power, Pennsylvania

Action on Minutes of Annual Meeting of 1939

Appointment of Committee on Subjects, Resolutions, Etc.

Unfinished business

New business

Report of General Committee

Report of Nominating Committee

Discussion of reports on:
- Lubrication of Cars and Locomotives
- Wheels
- Brakes and Brake Equipment
- Couplers and Draft Gears
- Tank Cars
- Loading Rules
- Car Construction

Friday, June 28

Educational Film—"Know Your Money"—United States Secret Service—Treasury Department

Report on "Intercrystalline Cracks in Locomotive Boilers," by W. C. Schroeder, A. A. Berk, and R. A. O'Brien, presented by Dr. W. C. Schroeder, senior chemical engineer, Eastern Experiment Station, Bureau of Mines, College Park, Md.

Discussion of reports on:
- Arbitration
- Prices for Labor and Materials
- Specifications for Materials
- Locomotive Construction
- Closing Exercises
- Adjournment

AMERICAN SOCIETY FOR TESTING MATERIALS.—W. M. Barr, chief chemical and metallurgical engineer of the Union Pacific at Omaha, Neb., has been nominated for president of the A. S. T. M. H. J. Ball, professor of textile engineering, Lowell Textile Institute, has been named for vice-president. Among the nominees for the Executive Committee are P. D. Merica, vice-president and director, International Nickel Co., Inc., New York, and Jerome Strauss, vice-president, Vanadium Corporation of America.

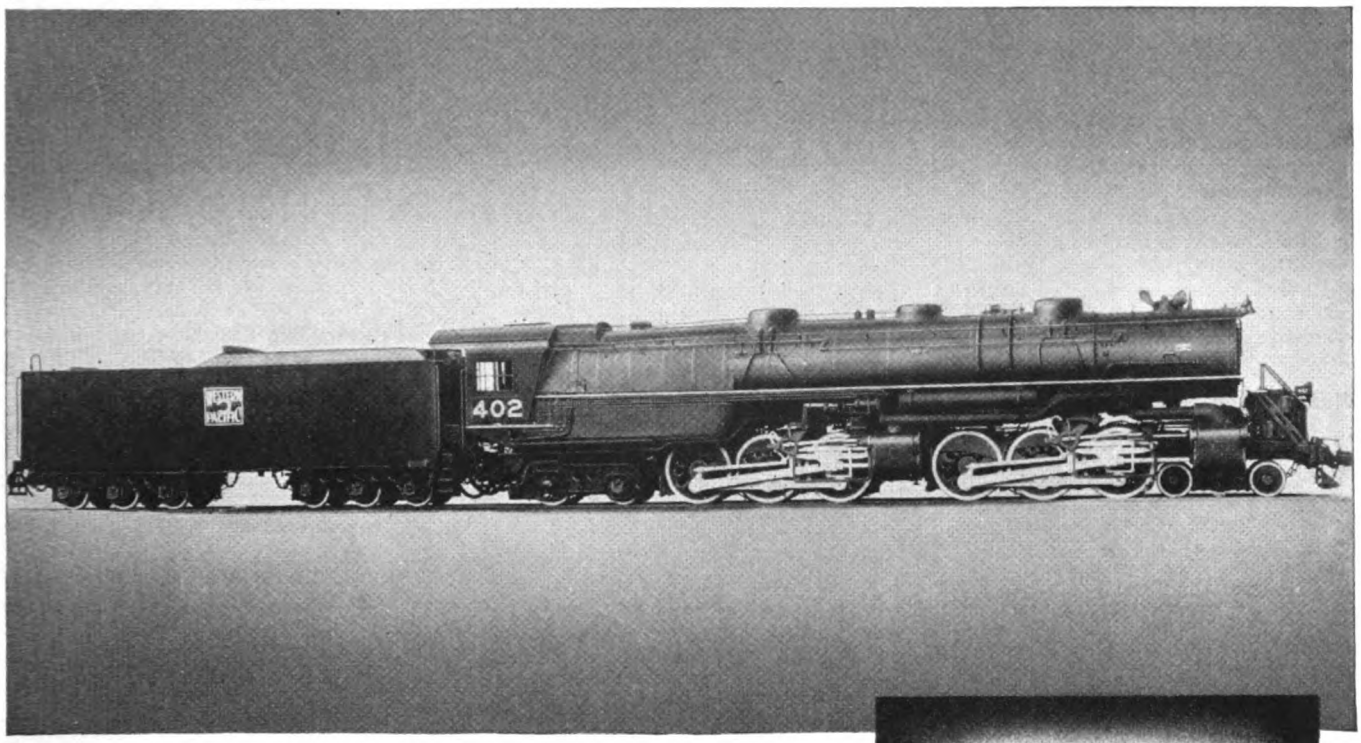
Club Papers

Braking Trains Under Modern Conditions

Car Foremens Association of Chicago. Meeting held Monday evening, May 13, at the Hotel LaSalle, Chicago. Address, "Braking Trains Under Modern Conditions," presented by L. K. Sillcox, first vice-president, New York Air Brake Company, Watertown, N. Y. ¶Mr. Sillcox departed from his prepared address and talked extemporaneously in explaining a series of lantern slides which depicted in spectacular fashion some of the more important problems and accomplishments in the field of modern high-speed braking. He described the development and primary functions of the "AB" brake, as well as brake equipment developed especially for lightweight, high-speed passenger trains. He referred to the exacting requirements of modern wheel service and stressed the possibilities of disc-type brakes in removing the braking load from car wheels. The importance of large diameter wheels, anti-wheel-sliding devices and improved sanding equipment for individual wheels was also stressed. ¶With reference to the introduction of various new types of air brake equipment and improved features of design to meet modern requirements. Mr. Sillcox said: "No one knows better than the manufacturer the extent to which the success of his designs, and, many times, even his reputation are in the hands of the men who must keep his product in service, once he has done his best work upon it before it leaves his inspection table. You are our employers and without your sympathetic co-operation, our lot would be hard. It is a privilege to acknowledge a debt of this sort. The men who direct and perform the operations which make the equipment of railways imposingly safe and reliable are contributing in no small measure to the improvement of service and to the ability of their administrations, beleaguered by as trying a set of conditions outside their control as can well be conceived, to sustain and improve the prestige of the industry. In return for your faithful service to our products in the field, we, as brake manufacturers, are ever eager to assist in improving your understanding of the parts which we place in your hands and to explain the reasons for their taking the forms in which you find them."

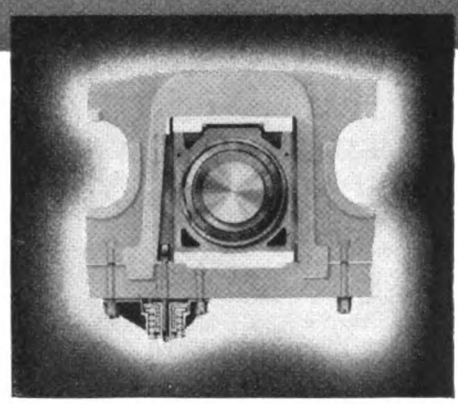
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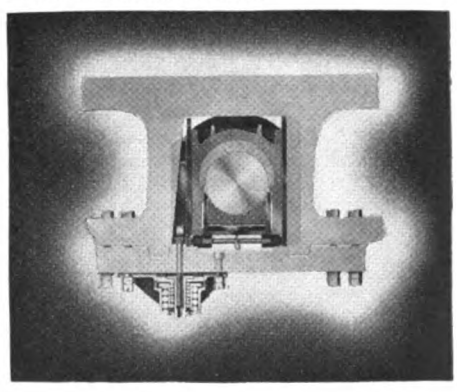
Protect your mallets . . .



. . . WITH FRANKLIN AUTOMATIC COMPENSATORS AND SNUBBERS

Mallets, because of the large number of drivers, formerly meant multiplied troubles because of improperly adjusted driving box wedges. This condition no longer bothers the progressive railroads as they now keep their wedges adjusted automatically and correctly . . . with Franklin Automatic Compensators and Snubbers. » » » The Automatic Compensator and Snubber maintains a constant accurate adjustment. It compensates for wear and for quick changes in temperature, which in many cases varies as much as 250 degrees in short periods of time. Slack & Pound are eliminated and the destructive effect of abnormal shocks is prevented. » » » Wedge adjustment worry is a thing of the past, even on Mallets. Our engineers will be glad to consult with you on applying Franklin Automatic Compensators and Snubbers to your new or old power.





ABOVE: Franklin Automatic Compensator and Snubber for Roller Bearing Driving Box application. BELOW: Franklin Automatic Compensator and Snubber for Friction Bearing Driving Box application.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK
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NEWS

William E. Woodard Awarded Henderson Medal

At its Medal Day exercises at Philadelphia, Pa., on May 15 the George R. Henderson Medal was awarded by the Franklin Institute to William E. Woodard, vice-president in charge of design, Lima Locomotive Works, Inc., New York. This medal is awarded for distinguished contributions in the field of railway engineering, and it was presented to Mr. Woodard "in consideration of his accomplishments in locomotive engineering and his important contributions in the field of steam locomotive design."

Dickerman and Hardy Elected to Ordnance League Posts

The New York Post, Army Ordnance Association, elected a panel of officers at its recent annual meeting, which included W. C. Dickerman, chairman of the board, American Locomotive Company, as director of the association and as a member of the Executive Committee, together with C. J. Hardy, president, American Car and Foundry Co. The association is a national society of citizens pledged to industrial preparedness, and was founded in 1919 to foster an understanding of industry's role in national defense.

Berwick Plant Celebrates Its Centennial

The Berwick, Pa., plant of the American Car and Foundry Company, a plow factory in 1840, now the company's largest car-building plant, celebrated its centennial on May 4 with events culminating in a dinner given by the Berwick Historical Society at the Hotel Berwick. "Industry and Education" was the theme of the double centennial of the beginning of industry in Berwick and the founding of education in the Berwick Academy, also in 1840. Addresses were made by Governor Arthur H. James of Pennsylvania, Judge E. Foster Heller of Wilkes-Barre, Pa., and President Charles J. Hardy of the American Car and Foundry Company.

In his address President Hardy said that $111,000,000 had been paid out in wages at the Berwick plant since the American Car and Foundry Company was formed in 1899 and that during this same period 230,000 railroad cars had been built at Berwick.

R. L. Templin Awarded Longstreth Medal

The Edward Longstreth Medal for the encouragement of invention was awarded by the Franklin Institute to Richard L. Templin, chief engineer of tests, Aluminum Company of America, New Kensington, Pa., at its Medal Day exercises at Philadelphia, Pa., on May 15. The award was made to Mr. Templin "in consideration of the ingenious application of mechanisms resulting in the development of the Templin automatic autographic deformation recorder."

Pullman Develops Triple-Deck Coach-Sleeper

Two triple-deck coach-sleepers, developed by the Pullman Company as an appeal to "economical travelers who want a real sleeping service at minimum charges for both transportation and the reserved accommodation," will be placed in experimental service during June and will be tried out on several railroads in various sections of the country.

Each car has 10 compartments located on one side. Five have seating and sleeping accommodations for three persons each and the remainder accommodate six persons each, or a total of 45 persons per car. The larger compartments have the same facilities as the smaller being, in effect, two three-person compartments with three seats on each side, facing each other, and no separating partitions.

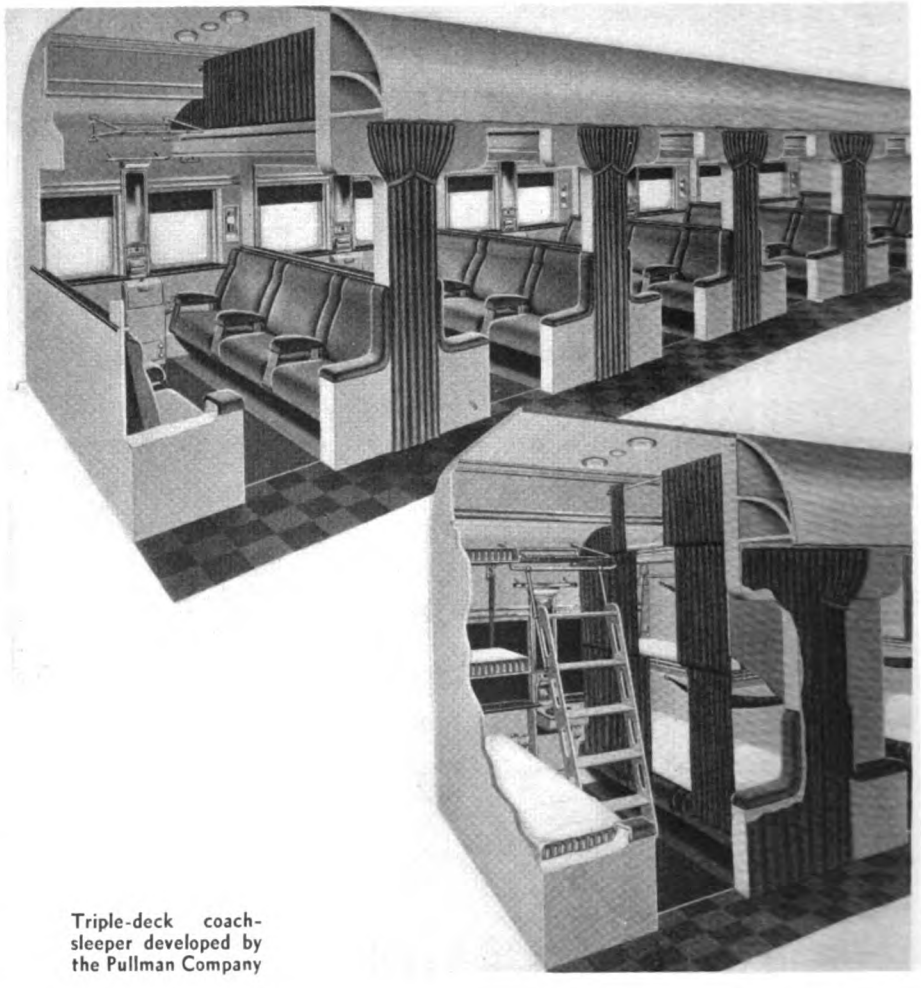
During day travel, passengers occupy upholstered seats, adjustable as to the slope of the backs and the height of the seat. Arm rests separate the three seats in each unit, and at night the two arm rests are folded into the seat. Individual foot rests aid comfortable day lounging.

The berths are in three tiers. The lower is formed by the seat back, similar to the bedroom couch bed. The upper berth is stationary, the bottom being well above the head of a tall person. The second, or intermediate, berth is a new development. It is raised against the upper during the day, and at night is lowered midway between the upper and lower, and forms a partition between compartments.

Each berth has individual curtains; also a shelf and a hammock for clothing and other belongings. A ladder is so placed that occupants of the two higher berths may ascend or descend without disturbing their compartment neighbors.

At the window end of each compartment are a wash basin, hot and cold water, a dental faucet, a mirror adequately lighted for toilet purposes and an electric shaving outlet. The basin folds closely to the car's

(*Continued on next left-hand page*)



Triple-deck coach-sleeper developed by the Pullman Company



ANYTHING

less than a complete arch

IS FALSE ECONOMY

To let the desire for reduced inventory result in a locomotive leaving any roundhouse without a full set of Arch Brick is poor economy. » » » Even a single missing Arch Brick will soon waste many times its cost in fuel and in locomotive efficiency. » » » To spend the fuel dollar efficiently, every locomotive Arch must be maintained 100%. » » » Be sure your stocks on hand are ample to provide fully for all locomotive requirements, so that locomotive efficiency may be maintained.

There's More to SECURITY ARCHES Than Just Brick

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.

Locomotive Combustion Specialists

outer wall and is locked in position. In addition to these facilities there are washrooms and toilets for men and women, at opposite ends of the car. A baggage compartment gives extra luggage space.

Aisle curtains will be drawn across compartment entrances during dressing periods. At night, when all passengers have retired, these curtains can be drawn back, as in daytime, for circulation of air.

Folding seats are placed along the aisle wall of the car opposite each compartment entrance, for the convenience of those awaiting the making or putting away of the berths. The coach-sleepers are air-conditioned, and at night each berth has a fresh-air inlet, individually controlled. The lighting system illuminates each seat, and there is a reading lamp in each berth. Attractive colors and fabrics are used in the decorations.

Franklin Institute Honors Union Carbide Research Head

DR. FREDERICK MARK BECKET, president, Union Carbide & Carbon Research Laboratories, Inc., New York, was the recipient of the Elliott Cresson Medal awarded by the Franklin Institute on May 15 at its Medal Day exercises at Philadelphia, Pa. This medal, awarded for distinguished contributions in the realm of physical science, was given to Dr. Becket "in consideration of his outstanding achievements in the development of processes for the production of low-carbon ferro alloys, which have led to the wide use of many of the now well-known alloy steels, particularly low-carbon stainless steels, and the higher chromium oxidation-resistant steels; and also for his many inventions and contributions in the field of electrometallurgy."

Microfilm Copies Available at Engineers' Library

THE Engineering Societies Library, 29 West Thirty-ninth street, New York, has broadened its services to engineers by making available at cost "microfilm" copies of the material contained in the 160,000 volumes and thousands of periodicals in its collection. Any engineer, library or company in any part of the world may order microfilm copies on 35-mm film at the cost of four cents per exposure with a minimum charge of $1.25 per volume, postage included. This service is in addition to that already available for supplying photostat prints at 30 cents each.

The Engineering Societies Library is a joint co-operative enterprise of the American Society of Civil Engineers, the American Institute of Mining & Metallurgical Engineers. The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

Equipment Purchasing and Modernization Programs

New York Central.—The New York Central has asked authority from the Interstate Commerce Commission to assume liability for $10,400,000 of two per cent equipment trust certificates, maturing in equal annual installments on June 1, 1941, and on June 1 of each year thereafter to and including June 1, 1950. The proceeds will constitute 90 per cent of the purchase price of equipment costing $11,571,100, consisting of 25 L-3-B Mohawk freight locomotives, 25 L-3-A Mohawk freight and emergency passenger locomotives, 1,500 55-ton all-steel self-clearing hopper cars, 500 70-ton all-steel bulk cement covered hopper cars, and one stainless-steel passenger coach.

Educational Program for Turret-Lathe Operators

AN educational program designed to aid in the training of apprentices and to help the experienced operators of the country's 55,000 turret lathes improve their skill has been announced by The Warner & Swasey Company, Cleveland, Ohio.

A "Turret-Lathe Operators Service Bureau" has been established, as announced by Clifford S. Stilwell, executive vice-president, and is designed to help the machine-tool-using industries solve the production problems which the lack of skilled mechanics creates every time operations reach a high level. The new service bureau will get under way immediately with a three-point program.

The bureau will send lecturers into manufacturing plants all over the country with sound slide films, charts and models, to show operators the modern and improved operating techniques of utilizing turret lathes and tooling equipment. A 240-page text book published by the Bureau will give operators an opportunity to improve their technique through home study. A monthly publication called "Blue Chips" will serve as the third arm of the program, affording opportunity for exchanging ideas and keeping operators posted on latest developments in their field.

Bureau lecturers will be available to visit technical high schools and colleges, as well as industrial plants. The program of instruction is introduced with the 20-min. slide film which emphasizes, among other things, the importance of further study and education. The lecture itself is built around ten fundamental principles of turret-lathe operation and is illustrated with drawings enlivened with cartoon characters.

The 240-page text book is devoted entirely to turret-lathe operation. It contains over 367 illustrations and complete charts and tables. The book is available to operators at a nominal price of $1.00 and to the general public at $2.50 per copy.

Blue Chips, the monthly publication, contains, for the most part, answers to questions sent in by operators, and tooling ideas and short-cuts which operators themselves have developed. Contributors are paid $3.00 for each idea printed.

Safety Vents on Sulphuric-Acid Tank Cars

THE Interstate Commerce Commission, by Commissioner Alldredge, has issued another of the Special Series A orders in the No. 3666 proceeding involving regulations for the transportation of explosives and other dangerous articles, granting an application filed by the Mechanical Division, Association of American Railroads, on behalf of the Manufacturing Chemists' Association for authority to install on 100 tank cars safety vents equipped with lead discs having 1/16 in. breather holes in the center. The cars thus equipped will be allocated for test purposes to shippers of sulphuric acid.

Orders and Inquiries for New Equipment Placed Since the Closing of the May Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Locos.	Builder
Chicago, Rock Island & Pacific	1[1]	1,000-hp. Diesel-elec.	American Loco. Co.
Terminal R. R. Assn. of St. Louis	2	1,000-hp. Diesel-elec.	Electro-Motive Corp.
	4	600-hp. Diesel-elec.	Electro-Motive Corp.
	2	660-hp. Diesel-elec.	American Loco. Co.
	2	660-hp. Diesel-elec.	Baldwin Loco. Wks.

LOCOMOTIVE INQUIRIES

Detroit, Toledo & Ironton	4 or 7	2-8-2 or 2-8-4	.....
Western Maryland	12	4-6-6-4	.....

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Chesapeake & Ohio	100	50-ton flat	Pullman-Std. Car Mfg. Co.
Cincinnati, New Orleans & Texas Pacific	75	70-ton hopper	Pullman-Std. Car Mfg. Co.
Great Northern	1,000	50-ton box	Pullman-Std. Car Mfg. Co.
Nashville, Chattanooga & St. Louis	50	70-ton hopper	Pullman-Std. Car Mfg. Co.
Tennessee Coal, Iron & R. R. Co.	16	70-ton air dump	Pressed Steel Car. Co.

FREIGHT-CAR INQUIRIES

Great Northern	1,000	50-ton box	.....

PASSENGER-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
New York Central	1	Stainless-steel Passenger coach	Edw. G. Budd Mfg. Co.
Canadian Pacific	See footnote[2]		
Western Rwy. of Alabama	2	Baggage-express	.....

[1] Delivery accepted.

[2] The Canadian Pacific is asking for prices on the construction of frames for 25 passenger coaches, on which interior work will be carried out in the company's own shops at Montreal, Que. The cars are to be air conditioned and have an overall length of 83 ft. 10½ in. between the coupler buckles and will have a clear inside length of 77 ft. 3½ in. The inside layout provides toilet rooms and drinking fountains at each end of the car, and the passenger space will be divided into two compartments—a smoking space seating 16, divided by a glass partition from the main portion of the car which provides seats for 56 passengers.

Supply Trade Notes

C. D. ALLEN, eastern sales manager of The J. S. Coffin, Jr., Company, Englewood, N. J., has ben appointed vice-president.

◆

WILLIAM TAGGART, representative of the Steel & Tube division of the Timken Roller Bearing Company, Canton, Ohio, has been appointed manager of tube sales.

◆

C. B. BOYNE, manager of stainless bar and wire sales of the Allegheny Ludlum Steel Corporation, Pittsburgh, Pa., has been appointed manager of stainless sales, with headquarters at Pittsburgh.

◆

W. A. BLUME, vice-president of the American Brakeblok division of the American Brake Shoe & Foundry Company, has been elected president of the American Brakeblok Division with headquarters at Detroit, Mich.

◆

S. W. GIBBS, assistant sales manager of the materials handling division of the Yale & Towne Manufacturing Co., at Philadelphia, Pa., has been appointed general sales manager of the Philadelphia division.

◆

EDWARD L. RYERSON, JR., vice-chairman of the board of the Inland Steel Company, Chicago, has been elected chairman to succeed L. E. BLOCK, who has retired. Mr. Block has been elected chairman of the executive committee.

◆

NORMAN L. DEUBLE is now associated with the Copperweld Steel Company, at Warren, Ohio, as assistant to vice-president. Mr. Deuble was previously with the Republic Steel Corporation and had been associated with the Central Alloy Company and the United Alloy Steel Co.

◆

GEORGE A. BLACKMORE has been elected chairman of the board of the Duff-Norton Manufacturing Company, Pittsburgh, Pa., succeeding the late Thomas A. McGinley. Mr. Blackmore is president and director of the Westinghouse Air Brake Company, the Union Switch & Signal Co.; a director of the A. M. Byers Company, the Pittsburgh Screw & Bolt Corp., the Pittsburgh Coal Company, the Flannery Bolt Company, the Bendix-Westinghouse Automotive Brake Company, the Cardwell Westinghouse Company, the Westinghouse Brake & Signal Co., Ltd. of London, the Canadian-Westinghouse Company of Hamilton, Ont., the Westinghouse Electric & Manufacturing Company, the Mellon National Bank, the National Association of Manufacturers, and the Chamber of Commerce of Pittsburgh.

Obituary

CHARLES H. JOHNSON, executive vice-president and director of the Gisholt Machine Company, Madison, Wis., died on April 23 at the age of 58 years.

◆

WALTER S. RUGG, who retired in May, 1936, as vice-president of the Westinghouse Electric & Manufacturing Co., died on April 25, in New York, at the age of 74 years.

◆

GEORGE LEWIS BOURNE, chairman of the board, The Superheater Company, and its affiliated Combustion Engineering Company, Inc., of New York, died on May 25, at his home in Larchmont, N. Y., at the age of 66. Mr. Bourne had been ill for several months.

◆

PAUL WYLER, formerly district manager of the Franklin Railway Supply Company, New York, for about 28 years previous to 1934, died on April 7, at his home in Dunkirk, N. Y. Mr. Wyler was a graduate of Purdue University. He served in the engineering department of Chicago, Rock Island & Pacific and was subsequently employed by the Bettendorf Company. He entered the service of the Franklin Railway Supply Company about 1906.

◆

ARTHUR G. HOLLINGSHEAD, whose death on April 23 at Chicago was announced in the May *Railway Mechanical Engineer*, was born at Zanesville, Ohio, on August 8, 1862. He entered railroad service at the Fort Wayne shops of the Wabash, and, after completing his boiler maker apprenticeship, became a locomotive fireman and engineman. He served as enginehouse foreman at several points on the Wabash and in 1892 was promoted to division master mechanic, with headquarters at Hudson, Ind. In 1896, he entered the supply business with the Scully Steel & Iron Company. Subsequently he was em-



Arthur G. Hollingshead

ployed by the Philadelphia Pneumatic Tool Company, the Murphy Car Roof Company and the Ralston Steel Car Company. In 1905, he entered business for himself and formed the Okadee Company. He expanded his interests in 1913 by affiliating with Harry Vissering & Company, Chicago, now the Viloco Railway Equipment Company, and the Charles R. Long, Jr., Company of Louisville, Ky. From 1929 until his death he was actively engaged as president of The Okadee Company and the Viloco Railway Equipment Company, both of Chicago, and the Viloco Machine Company of Benton Harbor, Mich.

◆

THOMAS A. MCGINLEY, president and chairman of the board of the Duff-Norton Manufacturing Company, Pittsburgh, Pa., died on April 13. Mr. McGinley was graduated from Yale University in 1901. Soon afterward he entered the employ of the Duff Manufacturing Company, and worked through its various departments



Blank & Stoller

Thomas A. McGinley

up to the presidency and board chairmanship of its successor organization, The Duff - Norton Manufacturing Company. During his early manhood he, with his father, was interested in several of George Westinghouse's enterprises, and at his death Mr. McGinley was a director of the Westinghouse Air Brake Company and the Union Switch and Signal Company, as well as numerous other concerns, including the Pittsburgh Screw and Bolt Company, the Fidelity Trust Company and the Allegheny General Hospital. Mr. McGinley was treasurer of the Eaglis Company. During the World War, he served in New York as district manager in charge of aircraft production for the United States Army.

◆

HUGH A. GILLIES, vice-president of the American Brakeblok division of the American Brake Shoe & Foundry Co., died of a cerebral hemorrhage at the Commodore Hotel, New York, on April 23, while on a business trip from his home in Detroit, Mich. Mr. Gillies was born at McComb City, Miss., in 1881. He started his business career as a machinist and mechanical engineer and served on a number of railroads in the United States and Mexico. He joined the American Brake Shoe Company in 1915, and was placed in charge of the company's Denver, Colo., plant and the sale of its products. When a new division was organized to manufacture automotive brake lining, Mr. Gillies was put in charge of sales.

(Turn to second left-hand page)

99.23% A

Six Rockets Make Records

The Rock Island's fleet of six smartly styled stainless steel streamlined "Rockets" has established an enviable performance record with the utmost in safety, comfort and economy.

The six "Rocket" locomotives, built by Electro-Motive Corporation and each powered by one General Motors 1200 horsepower two-cycle Diesel engine, entered service in the fall of 1937. The records shown are from the date of installation to January 1, 1940.

Entered Service in Fall of 1937

28 MONTHS Average Time in Service



vailability

2,986,317
Total Miles Operated

99.23%
Average Availability

$.08
Average Maintenance Cost per Mile

112,299
Average Assigned Miles per Month

Rock Island

ROCKETS



GM
GENERAL MOTORS
DIESEL POWER

ELECTRO-MOTIVE CORPORATION
SUBSIDIARY OF GENERAL MOTORS — LA GRANGE, ILLINOIS, U. S. A.

Personal Mention

General

JOHN ZWEIFEL, assistant mechanical and electrical engineer of the New York Central, with headquarters in New York, has retired after almost 34 years of service.

G. A. CLARKE, supervisor of auxiliary equipment on the New York, New Haven & Hartford, has been promoted to chief mechanical inspector at New Haven, Conn. Mr. Clarke entered the employ of the New Haven in 1923 as a material inspector and in 1928 became assistant to the mechanical engineer. From 1930 to 1936 he was assistant engineer of power plants and then became supervisor of auxiliary equipment.

ELWOOD R. BUCK, who has been appointed superintendent of motive power of the Wabash, with headquarters at Decatur, Ill., as announced in the May issue, was born on December 2, 1894, at Altoona,



Elwood R. Buck

Pa., and was educated at Pennsylvania State College. He entered railway service on the Pennsylvania on June 26, 1913, and completed a special apprenticeship in 1920. On April 1, 1923, he was promoted to assistant master mechanic of the Trenton division, and on January 1, 1931, was transferred to the Baltimore division. He served also at other points on the Pennsylvania as assistant master mechanic and was master mechanic at Pitcairn, Pa., at the time of his recent appointment as superintendent of motive power of the Wabash at Decatur.

PHILIP BAKER has been appointed assistant superintendent of motive power of the Lehigh Valley, with headquarters at Sayre, Pa. Mr. Baker was born on October 3, 1890, at Nashville, Tenn., and entered railway service in February, 1907, with the Nashville, Chattanooga & St. Louis as a machinist apprentice. He served as machinist on the Nashville, Chattanooga & St. Louis; St. Louis & San Francisco; Louisville & Nashville; Tennessee Central; Southern; and the Florida East Coast. From 1927 to 1934 he served the Wabash as gang foreman; assistant machine foreman; and assistant master mechanic. In March, 1934, Mr. Baker was appointed general foreman of the Belt Railway of Chicago, subsequently becoming master mechanic, in which capacity he served until his recent appointment on the Lehigh Valley.

Master Mechanics and Road Foreman

MARK P. SMITH, assistant road foreman of engines of the Scioto division of the Norfolk & Western at Portsmouth, Ohio, has retired.

T. L. PREUN, foreman at the Hoboken shop of the Pennsylvania, has been appointed assistant master mechanic of the Philadelphia division.

C. A. WILSON, master mechanic of the Williamsport division of the Pennsylvania at Renovo, Pa., has been transferred to the Middle division with headquarters at East Altoona, Pa., succeeding J. L. Marks.

W. R. JACKSON, assistant road foreman of engines on the Radford division of the Norfolk and Western, has been transferred to the Scioto division, with headquarters at Portsmouth, Ohio, succeeding Mark P. Smith, retired.

W. A. NOELL, passenger equipment inspector of the Norfolk and Western at Roanoke, Va., has been appointed assistant road foreman of engines, with headquarters at Roanoke, succeeding W. R. Jackson.

H. C. WRIGHT, assistant master mechanic of the Philadelphia division of the Pennsylvania, has been appointed master mechanic of the Williamsport division, with headquarters at Renovo, Pa., succeeding C. A. Wilson.

G. M. LAWLER, master mechanic on the Atchison, Topeka & Santa Fe at Dodge City, Kan., has had his headquarters transferred to LaJunta, Colo. His jurisdiction now includes the enginehouse, locomotive and car departments at LaJunta.

W. C. SMITH, assistant master mechanic of the New Haven division of the New York, New Haven & Hartford with headquarters at New Haven, Conn., has been appointed master mechanic, with the same headquarters.

HARRY E. MILLS, road foreman of engines on the Northern Pacific at Duluth, Minn., has been appointed acting master mechanic, with the same headquarters, succeeding Norman P. White, who has been granted a leave of absence.

J. L. MARKS, master mechanic of the Middle division of the Pennsylvania, has been appointed master mechanic of the Pittsburgh, Conemaugh and Monongahela divisions, succeeding E. R. Buck.

R. V. K. JENNINGS, general foreman at the Maybrook (N. Y.) enginehouse, of the New York, New Haven & Hartford, has been appointed assistant master mechanic with headquarters at New Haven, Conn.

Shop and Enginehouse

JOHN O. ROSE, night enginehouse foreman on the Louisville & Nashville at Corbin, Ky., has become day enginehouse foreman at Corbin.

DAVID G. ROOT, gang foreman in the backshops of the Louisville & Nashville at Corbin, Ky., has become night enginehouse foreman, succeeding John O. Rose.

C. P. BROOKS, supervisor of apprentices of the Erie at Cleveland, Ohio, has been promoted to general foreman, locomotive department, at Marion, Ohio.

WILLIAM JASPER YOUNG, machine shop foreman on the Louisville & Nashville at Corbin, Ky., has been promoted to the newly created position of foreman of erecting and machine shop at Corbin

F. WHITAKER, chief mechanical inspector on the New York, New Haven & Hartford at New Haven, Conn., has been promoted to the position of assistant superintendent of the Readville (Mass.) shops. Mr. Whitaker entered the employ of the New Haven in 1914 as a draftsman in the mechanical department at New Haven. In 1919 he became valuation inspector and in 1932 was appointed foreman mechanical inspector at Readville shops. In 1939 he was appointed chief mechanical inspector.

Car Department

H. H. ZERBACH, foreman of the car department at the Emerson shops of the Atlantic Coast Line at Rocky Mount, N. C., has been appointed general foreman.

J. LEE HARRISON, foreman in the car shops of the Atlantic Coast Line at Jacksonville, Fla., has been appointed foreman, car department, Emerson shops, Rocky Mount, N. C., succeeding H. H. Zerbach.

Obituary

JOHN L. BRADY, foreman of the car department of the Louisville & Nashville at DeCoursey, Ky., died on March 29.

ARTHUR G. PHILLIPS, superintendent of machinery and tools of the Delaware, Lackawanna & Western at Scranton, Pa., died in that city on May 7.

SAMUEL RUSSELL, assistant to the general master mechanic of the Boston & Albany, at West Springfield, Mass., died at the age of 67 at his home in Springfield, Mass. Mr. Russell was born at Ghent, N. Y., on March 13, 1873. He began his railway career on the B. & A. on July 20, 1899, as a locomotive fireman. On January 15, 1903, he became an engineman and on October 10, 1910, was promoted to the position of road foreman of engines, with headquarters at Albany, N. Y. On January 1, 1924, Mr. Russell was appointed division master mechanic with headquarters at West Springfield, Mass., and on October 1, 1938, he became assistant to the general master mechanic. He was a member of the New England Railroad Club and an organizer and past president of the B. & A. Supervisors' club.

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July, 1940

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MECHANICAL DIVISION PROCEEDINGS NUMBER

★

Mechanical Division Reports:

Significant Results of Research Reported at Mech. Div. Meeting 245
Address by C. H. Buford 247
Chairman Hankins' Address 248
Commissioner Patterson Speaks 249
Remarks by Director Hall 249
Lubrication of Cars and Locomotives 250
Report on Wheels 251
Report on Brakes and Brake Equipment 254
Report on Couplers and Draft Gears 255
Report on Tank Cars 259
Report of Committee on Loading Rules 261
Intercrystalline Cracks in Locomotive Boilers 262
Report of Arbitration Committee 265
Report on Labor and Material Prices 269
Report on Specifications for Materials 270
Locomotive Construction 271
Report on Car Construction 277

General:

Automatic Train-Signal Recorder 285
Blow-Off Valve for Enginehouse and Power Plant 286
Unit Truck and Brake Beam 286
Water on the Troubled Oil (A Walt Wyre story) 290
Combined Governor and Reducing Valve 294
Four-Wheel Truck for Passenger Cars 294
Air-Operated Riveting Hammer 294

Editorials:

Railway Capacity for National Defense 287
Mechanical Officers Hold Excellent Meeting 287
Diesel Locomotive Operating Costs 288
New Books 289

High Spots in Railway Affairs 295

News 296

Index to Advertisers ..... (Adv. Sec.) 44

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The Spearhead . . .

TREMENDOUS POWER

•

WIDE SELECTION OF SPEEDS

•

WIDE SELECTION OF FEEDS

•

ELECTRIC INTERLOCKING LIMIT SWITCHES

•

FOOLPROOF CONTROL

•

THREE CUTTING HEADS

For the Drive on the High Cost of Repairs

After the locomotive has been stripped, the rest of your schedule almost four-fifths, depends upon the efficiency of your machine tools.

If the erecting floor has to wait for repair parts, delays are inevitable and the cost of classified repairs is bound to be excessive

Installation of New CUT MASTER Vertical Turret Lathes offer unusual economies — not only in the cost of machining locomotive parts but also through the obvious savings that will be effected on the erecting floor.

Analysis of the outstanding features, noted above in the red arrow will quickly show the reasons why CUT MASTER Vertical Turret Lathes offer one of the best paying investments that can be installed in a locomotive repair shop.

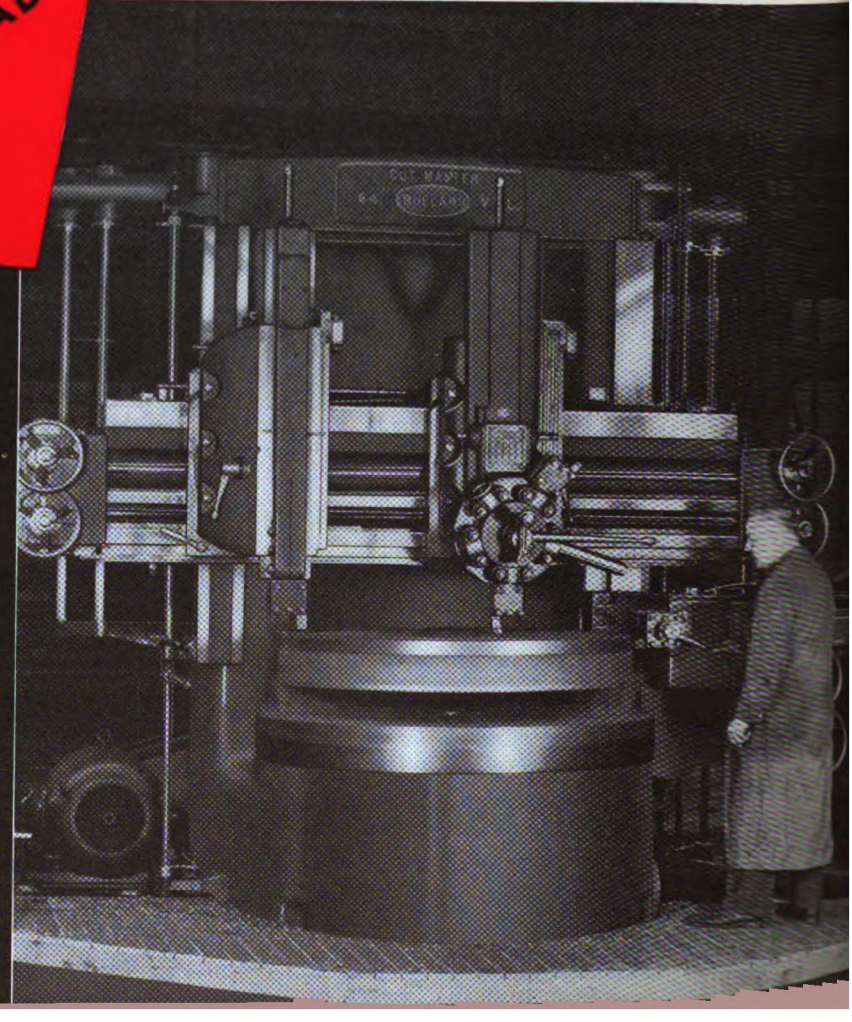
THE BULLARD COMPANY
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BULLARD

CUT MASTER

Vertical Turret Lathes

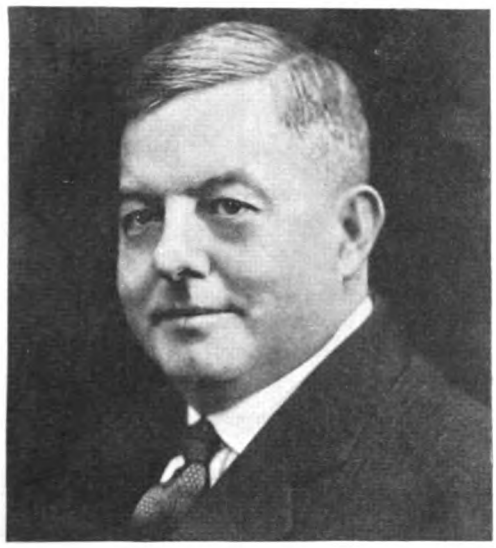
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Significant Results of Research Reported at

Mechanical Division Meeting

Revised passenger-car axle design increases strength at wheel seat from 60 to 80 per cent—Progress reported on caustic embrittlement research—Changes in the loading rules to be adopted without submission to letter ballot



F. W. Hankins, Chairman



W. H. Flynn,
Chairman elect



V. R. Hawthorne,
Secretary

THE results of two important research projects in which the Mechanical Division is directly interested were reported at the eighteenth annual meeting of the Mechanical Division of the Association of American Railroads which was held in the South Ballroom of the Hotel Stevens, Chicago, June 27 and 28. Dr. W. C. Schroeder, senior chemical engineer, Eastern Experiment Station, Bureau of Mines, College Park, Md., presented a report, of which he and A. A. Berk, assistant chemist, Eastern Experiment Station of the Bureau of Mines, and R. A. O'Brien, assistant metallurgist, Joint Research Committee on Boiler Feedwater Studies, attached to the Eastern Experiment Station, were joint authors. This report brings up to date the results of the research supported jointly by the Association of American Railroads and five other organizations. New designs for passenger-car axles were presented for adoption by the Car Construction Committee. These designs were developed as a direct result of the laboratory studies which have been conducted for the Mechanical Division during the past two and one half years in the Axle Research Laboratory at the Timken Roller Bearing Company.

During the opening session addresses were delivered by C. H. Buford, vice-president, Operations and Mainte-

nance Department, A. A. R., and by F. W. Hankins, assistant to vice-president and chief of motive power, Pennsylvania, who also presided, as chairman of the Mechanical Division. Other addresses were delivered during the meeting by W. J. Patterson, member, Interstate Commerce Commission, and by J. M. Hall, director, Bureau of Locomotive Inspection, Interstate Commerce Commission.

Following the addresses and the usual opening business, the General Committee reviewed its actions since the last annual meeting at New York in June, 1939. The committee reported that the membership of the Division at the present time includes 220 railway systems, full members of the Association of American Railroads, and 182 railways, associate members of the A. A. R., and that these railroads, members and associate members of the A. A. R. have appointed 827 representatives in the Mechanical Division. There are in addition, 564 affiliated and 428 life members in the Division.









Above:
D. S. Ellis

Right:
O. A. Garber

Lower right:
A. G. Christy

Below:
A. L. Ralston

In referring to the work of the Committee on Loading Rules, the General Committee asked for a resolution to approve its recommendation that new and revised loading rules hereafter be approved by viva voce or rising vote of representatives attending the annual meeting or by the General Committee between member meetings without the necessity of letter ballot. The committee pointed out that most changes in these rules are only recommended following extensive experimental shipments and approval or acceptance by the shippers, and that the shippers are demanding that the approval of new rules be expedited so that they can be placed in effect more promptly.









Above:
J. Purcell

Left:
R. G. Henley

Lower left:
H. B. Bowen

Below:
E. B. Hall

The committee reminded the member roads that as of December 31, 1939, 293,473 railroad owned and 24,621 private-line cars, or a total of 318,094 interchange freight cars, or 15.4 per cent, were equipped with AB brakes. Under date of March 20, 1940, the committee reported that a circular letter had been sent to all car owners asking advice as to what, if any, program had

been instituted to comply with the provisions of Interchange Rule 3, section (a), paragraph (4), by January 1, 1945.

The General Committee cited the action taken to provide for the home movement of cars equipped with arch-bar trucks after December 1, 1941, and then called attention to the adoption by letter ballot in February of a modified paragraph (4), section (t), Interchange Rule 3 to prohibit acceptance of cars equipped with arch-bar trucks in interchange, effective July 1, 1940. The modified rule is now published in Supplement No. 1 to the current rules of interchange issued in March, 1940.

Arrangement is being developed by the General Committee to provide dies for the manufacture of parts for the A. A. R. design of auto deck, and that when this arrangement is completed, members will be advised by circular.

Following the presentation of the General Committee report, a resolution embodying the recommendations of the General Committee with respect to the approval of the Loading Rules without letter ballot was adopted and the actions of the committee since the last meeting approved.





Above:
George McCormick

Left:
H. H. Urbach

At the opening of Friday morning's session two educational films were shown to the Mechanical Division by a representative of the United States Secret Service, Treasury Department. The first recounted the process of the manufacture of paper money and United States bonds, showing the various steps in the processes of engraving, printing, inspection, sorting and shipping. The second, entitled "Know Your Money," described the various kinds of paper money and their outstanding characteristics, by the comparison of which with counterfeit money the spuriousness of the latter is most readily detectable.

Election of Officers

The following candidates proposed by the Nominating Committee were elected as officers and members of the General Committee: W. H. Flynn, general superintendent motive power and rolling stock, New York Central, chairman (2-year term); R. G. Henley, superintendent motive power, Norfolk & Western, vice-chairman (2-year term); members of the General Committee (2-year term): F. W. Hankins, assistant vice-president-chief motive power, Pennsylvania; D. S. Ellis, chief mechanical officer, Chesapeake & Ohio; O. A. Garber, chief mechanical officer, Missouri Pacific; J. Purcell, assistant to vice-president, Atchison, Topeka & Santa Fe; A. L. Ralston, general mechanical superintendent, New York, New Haven & Hartford; and G. C. Christy, general superintendent of equipment, Illinois Central.

Address by C. H. Buford

In opening his address Mr. Buford expressed his pleasure at appearing before the Mechanical Division and continued in part as follows:

The railroads today constitute one of the first lines of defense of the country. Due to the splendid work of standardization of equipment and operating methods which has been carried on by the various railroad departments, the railroads were never in better shape to face such a task than they are today.





Above:
Otto Jabelmann

Right:
W. I. Cantley,
Mechanical engineer

The early founders of your Association realized the importance of exact information that could be obtained only through tests conducted under careful supervision, which is sometimes designated as applied research. In looking through the file of your proceedings, we find that as far back as 1875, you were engaged in testing practically of the various parts of cars and locomotives. In a great deal of this work, laboratories were utilized much as they are today, including those of Stevens Institute of Technology, Purdue University, and the laboratories of a number of railroads and railway equipment companies. Then, as now, the various groups of industries supplying materials and equipment to the railroads cooperated wholeheartedly in this work.

In more recent years, your division has conducted extensive research and tests on such important subjects as air brakes, freight car trucks designed for high-speed service, condensation in freight cars, draft gears, spring snubbers, etc. At the present time, you are making extensive tests of passenger car axles, and at this meeting,

as a result of this research, you are recommending the adoption of modified design for passenger car axles for high-speed service.

Research Points the Way to Further Improvements in Railroad Equipment

These tests and this research point the way to further advances in the art of design of railroad equipment to meet conditions which are becoming more and more exacting. Much credit also belongs to the manufacturers of materials and equipment which the railroads use. With your cooperation, these companies are continually experimenting in their shops and laboratories with improved methods, materials and equipment which are perfected for use.

There must be no letup in your program of advancement in knowledge and development. If the railroads are to continue to fulfill their carrier obligations and be able to expand and improve their services to meet changing conditions, you must continue the vigorous and courageous exploration of all possible means to increase the efficiency, dependability, safety and economy of the railroad service as it is affected by equipment and the facilities under your jurisdiction.

Another point I want to mention is the need for prompt prosecution of any test or research problem under consideration. I refer not only to problems that are strictly mechanical, but also to those that have to be worked out jointly with other divisions or sections of the Association. I note that at this meeting, your committees are presenting completed reports on a number of important matters, along with progress reports on other subjects. I believe the position of Mechanical Engineer which was established on the recommendation of your General Committee about two and a half years ago has contributed to the prompt handling of many matters.

Railroads Essential to National Defense

I have said that the railroads constitute one of the first lines of defense of this country. The railroads have always recognized that fact, and even through the depression years have been working with the War Planning Board to determine the means and methods required to best serve the nation in the event of a grave emergency.

Now that our country is starting on a large and much-needed program of national defense, there are some who question the ability of the railroads to handle whatever increase in business may materialize. No one knows what the increase will be, but there are those who make a guess, based on some business index they select. They then count the number of locomotives and cars owned by the railroads, find out the age of the units of equipment, and, using their guess as to the prospective traffic to be moved, tell us how many thousand locomotives and how many hundred thousand cars the railroads should buy.

Some of this advice comes to us from those who have had no railroad experience except such as they get from a study of statistics, and even then they have not considered or do not know how to evaluate all of the statistics bearing on the subject.

It is generally accepted that if we need legal advice, we should go to a lawyer, and if we need medical advice, we should go to a doctor. It follows that if information is wanted about railroads, the railroads themselves should furnish it. The Association of American Railroads, which represents practically all of the Class I railroads in the United States, has just completed a study of the equipment situation on its member lines, and I want to give you the results of that study. I do this because some of you here today are interested in industries which furnish cars and locomotives to the railroads, and are probably wondering if there is immediate prospect for large orders for rolling stock.

Railroads Equipped to Handle Expected Traffic Peak This Fall

As of June 1st this year, the railroads had 35,784 more serviceable cars than they had in October, 1939, at which time the average loading was 843,736 cars per week with a peak of 861,000 cars in the week ending October 21. With the new cars on order and the number that can be placed in service by repairs, we will have sufficient equipment to handle a much higher peak load this fall than was handled in 1939. From a careful study of our loading record during the World War and since that time, we can find no basis for an estimated loading at the peak this year that will be in excess of what the railroads can handle.

Unless there is a real need for additional equipment, or unless there is some economy to be gained by adding cars and locomotives, there is no reason why railroads should buy them or should even put money into repairing bad-order equipment. The railroads do not now need more equipment than they have. The only reason, therefore, that railroads might be expected to purchase more equipment would be to reduce operating costs. Wherever opportunities of that sort exist, and especially considering low interest rates and higher prices for the scrap in the old unit, railroads might be interested in additional equipment.

Chairman Hankins' Address

Chairman Hankins reviewed some of the important matters which have come up since the last annual meeting and commented on some of the outstanding subjects which would be brought before the members of the division in committee reports.

The improvement in general business conditions during the past year has imposed additional problems. Forecasts of the Shippers' Regional Advisory Boards indicates a further considerable increase in business for the railroads for the year 1940. With the decrease in ownership of freight cars during the past ten years, it is important that bad order cars be kept at the minimum and that serviceable cars be utilized to the greatest extent possible. By reason of improved materials and methods of construction and repairs, a lesser number of freight cars of today can perform more transportation service than a greater number of cars of older types. Improved motive power and transportation methods provide also for quicker turn-around of freight cars, resulting in the cars handling more loads and making greater revenue mileage a year.

Much is yet to be accomplished in improving the motive power and equipment. The arch-bar truck has been eliminated from interchange, but improvement in trucks is imperative to enable freight to be handled more expeditiously and without damage. As conditions permit, application should be expedited of the improved freight brake and certified draft gear to improve train handling and lessen damage to lading and equipment with the quickening of train schedules.

During the past year, upon recommendation of your General Committee, tests were conducted of trucks designed for high-speed freight service. Report of these tests will make available to truck manufacturers information and data upon which to base their designs of trucks

for high-speed freight service, indicating the direction in which they should be developed.

The research program of this division for passenger car axles has resulted in recommendation by the Committee on Car Construction for adoption of new design of axle for the various journal sizes for new passenger cars. Further research is being conducted to develop the best specification for material for axles for heavy-duty service. This will be prosecuted so that final recommendation will be available early next year.

Complaints have been made to the General Committee that excessive repairs are being made to foreign cars—especially to empty cars that are delivered to owners by direct connection immediately after completion of repairs. The member roads were requested by your General Committee to report their bills against foreign and private car lines on a car-day basis for a period of eighteen months. After analysis of these reports, special investigations were made where billing was out of line with the average. As a result, the Arbitration and Price Committees are reviewing all labor and material allowances in the Interchange Rules, to the end that such allowances will be established so as to reimburse the repairing line for labor, material and overhead expense incurred in repairing foreign cars and contain no element of profit. While the survey is not yet completed, the Price Committee in its report for this year is recommending such readjustment in material prices and labor allowances as is indicated to be necessary. The Arbitration Committee is recommending revision of Interchange Rule No. 1 to make clear the intent that repairs should be made by the car owner insofar as may be practicable, and that repairs to foreign cars shall be confined to the minimum necessary for safety of operation.

Shippers of heavy freight—sheet steel in bundles, coiled strips, etc.—have adopted a practice of loading these commodities in box cars by the use of lift-truck tractors that impose loads on floors of box cars at the doorway that were never contemplated when the present car designs were prepared and adopted. The Car Construction Committee is recommending reinforcement for car floors used in such service. The Car Construction Committee recommends also a standard contour for passenger cars.

Both of these recommendations should have your careful consideration.

The Committee on Couplers and Draft Gears during the past year has carefully reviewed the experience of the member roads with the tight lock coupler that was adopted as Recommended Practice in 1937 and last revised in 1939. As a result of this study, Circular No. DV.-977 was issued under date of April 3, 1940, containing instructions for making adjustments to improve lock anti-creep. On the same date, there was issued Circular No. D. V.-976 containing revised instructions governing operation, inspection and maintenance of tight-lock couplers.

The report of the Committee on Wheels, which will be discussed at this meeting, contains important recommendations for revision and improvement of specifications for cast iron wheels and the adoption of specifications for heat-treated wrought steel wheels. This report is commended to your careful and thoughtful consideration.

The report of the Committee on Locomotive Construction contains much useful information. This committee reports on a number of important phases of locomotive design.

All of the committee reports that will be discussed at this meeting represent careful and painstaking effort. It has been our purpose not to point out the work of any particular committee, but to refer to some of the important matters covered in this year's reports and to direct your attention to all of the reports that will come before you for your discussion and disposition.

Commissioner Patterson Speaks

W. J. Patterson, member, Interstate Commerce Commission, in speaking briefly to the opening session of the Mechanical Division, said that his remarks would largely be related to matters with which he was formerly deeply concerned as director of the Bureau of Safety, since his work as commissioner had not been closely related to matters with which the members of the Mechanical Division are concerned. He expressed the hope that by July 1 the arch-bar truck would be completely extinct. He also emphasized the need for action in carrying out the program of replacing the old freight-car brakes with the improved type brake. The development of brakes for operation in high-speed service, he said, had been more rapid in passenger service than in freight. He cited as evidence of the need for a higher braking ratio on heavily loaded cars, a case in which a freight train approaching a junction at a relatively slow speed overran the switch and was sideswiped by a train on the main track. Investigation, he said, would probably show that the braking ratio on this train was down around 16 per cent, which he considers to be entirely too low.

Mr. Patterson commented particularly with respect to free slack in freight-car couplers. He said that he based his opinion on the fact that fewer break-in-twos are now occurring as the result of free slack or of the dropping of couplers.

Progress was being made, Mr. Patterson said, in the design of lightweight passenger rolling stock to insure safety of the new designs. He referred to the development of equipment and facilities for the testing of full-size samples of new designs and recommended that no new designs be established without a sample first being subjected to a suitable test. He expressed his confidence in the tight-lock coupler designed to take a vertical load of 100,000 to 150,000 lb. as an important safety device in passenger service. In case of derailment or wreck from other causes, such couplers tend to keep the train in line and thus avoid the unpredictable type of structural failures which may occur when the cars separate and are thrown violently out of line.

Mr. Patterson emphasized the importance of terminal inspection of air brakes, which some railroads are inclined to neglect, in insuring the control of trains under all conditions on the road. He also reminded the railroads that the constitutionality of the stoker order has been established by the Federal Court of the United States, and that the Interstate Commerce Commission has no authority to make any exceptions to the application of the order unless the applicant is clearly outside its scope.

Remarks by Director Hall

J. M. Hall, director, Bureau of Locomotive Inspection, Interstate Commerce Commission, called upon by Chairman Hankins, reiterated Commissioner Patterson's caution concerning the holding off too long on the equipment of locomotives with stokers. He reminded the members that the stoker order requires equipment of 20 per cent of the locomotives requiring stokers each year

during the five-year period within which the work must be completed.

Mr. Hall also suggested that it would be well for the roads not to get caught on the last year within which the equipment of locomotives with power reverse gears must be completed with too large a part of the program still ahead of them.

Some roads, he said, are reluctant to equip their steam-locomotive water glasses with quick-closing valves. In such cases, he said, it was the practice of some enginemen after testing the glass not to open the valves wide but merely to crack them in order that they may be closed quickly and thus guard the men against burns, should the glass break. This, he said, is contrary to good practice in the matter of assuring free openings between the boiler and the water glass, and may result in false water indication.

In commenting on previous remarks concerning the need for more equipment, he suggested that things are moving pretty fast in Europe and that one is not likely to be given much time to meet changing conditions. He cited the case of one important road on which 27.6 per cent of the locomotives are now in or awaiting shop. This he does not consider particularly safe preparation for the future, whatever the situation may be as to the adequacy of the actual number of cars and locomotives owned.

In commenting on the inspection of locomotives other than steam, Mr. Hall said that there was no rule as to exactly what employee should make the inspection of these locomotives, so long as he was competent. He referred to the desire of some roads to have inspections done by the engineman since by this means it becomes unnecessary to bring the locomotive into the engine terminal. This, he said, is not objected to, but the inspection must be made. Seat-box inspections by the engineer are utterly inadequate to locate and report such defects as cracked wheel flanges, checked spring bands, cracks in the bolsters and other similar defects.

Lubrication of Cars and Locomotives

The committee held two meetings during the past year devoted to the questions of business held over from previous years or new business referred to it through the office of the secretary, or former chairman, E. L. Johnson. Since no new subjects pertaining to locomotive lubrication have come up during the year, our report this year covers general subjects relating to the lubrication of car equipment only.

Dust Guards

Last year's report included suggested revision of the current specifications M-903-34 recommended by the committee to be circularized among the members of the Association for comment. During the year suggestions and criticisms have been received and samples of dust guards from a number of manufacturers accumulated by a sub-committee who report progress only for this year. The sub-committee is undertaking further study and tests with a view of developing recommendations for a revision of specifications M-903 to include some limitations covering materials and workmanship. The dimensional modifications proposed during 1938-1939 of the upper portion of the guards to prevent forcing out the top dust-guard well wedges has been approved by the association during the year.

Interchange Rule No. 66

During the year a number of subjects relating to proposed changes or additions to clauses of Rule No. 66 were referred to and handled by the committee as follows:

Question of owners' vs. handling-line responsibility for imbedded waste grabs in journal bearings.

Action: The committee is unanimously of the opinion that Section (j) should not be amended to include imbedded waste grab in journal bearing as owners' responsibility.

Question of condemning limit for end wear of freight-car journal bearings as applied to bearings originally applied shorter than standard.

Action: The interpretation by the majority of the committee members was that paragraph (j-2) covers end wear based on the standard journal-bearing length and that no change is necessary to apply the limits of end wear as therein stated to worn bearings originally applied having length shorter than standard.

Proposed that free oiling journal boxes—freight equipment in interchange be made mandatory.

Action: The action of the committee based on the majority opinion of the members was that it would not be desirable to incorporate in the Rules a requirement to cover the use of free oil, but that its use be left as at present to the judgment of the individual road.

Standard method of packing journal boxes—present "one-piece" vs. proposed "roll method."

Action: The opinion of committee members was divided as between the two methods of packing boxes: both methods considered satisfactory. Tests are to be undertaken during the coming year by several members on their roads to develop facts based on comparative service performance. No definite recommendation for change from the present standard is made at this time.

Proposed setting up of labor price (Rule 107) to cover trimming over-run babbitt on journal bearings with "brass-trimming machines" at periodic re-packing periods required by Rule No. 66.

Action: After full discussion of the proposition involved in the use of the brass trimming machines and the practice of trimming the over-run lining of bearings otherwise serviceable and replacing them on the same journals for further service, the committee does not recommend the practice of trimming journal bearings on cars of foreign ownership.

Joint Sub-Committee on Journal Boxes and Contained Parts

This joint sub-committee having membership from the Committee on Car Construction and the Committee on Lubrication of Cars and Locomotives held two meetings during the year. The subjects handled, as they had bearing on the question of lubrication, included: (1) Question of dimensional changes in journal bearing design as related to the over-heating of 6½-in. by 12-in. bearings in locomotive tender service; (2) question of modification in the roof in the inside of journal boxes A, B, C, D, E, and F, to provide better contact surface between roof and wedge and thereby permit of proper movement and alignment to reduce bearing over-heatings; (3) question of waste-retaining ribs in journal boxes to prevent packing rolling and over-heatings due to strands getting between journals and bearings; and, (4) consideration of the question of dimensional modifications and reducing manufacturing and running tolerances of parts comprising the journal box assembly with a view of better control of lateral and a consequent reduction in over-heatings attributable to the lubrication of parts taking the lateral thrust.

Inasmuch as the final action on the above questions all involve dimensional changes and the design of parts, they come properly under the jurisdiction of the Committee on Car Construction and will not, therefore, be other than referred to in this report.

Report of Joint Sub-Committee on Journal-Box Lubricating Materials

Your joint sub-committee, since its authorization on May 27, 1936, has carried out studies of journal-box lubricating materials and has made annual reports to you with such suggestions for revision of the oil, waste, and packing specifications as were deemed justified by the information developed through surveys and tests carried out each year. A brief review of the work carried out during the past four years is summarized in this year's report.

1936-1938 Survey of Renovated Oils, Wastes and Packings

Information pertaining to facilities and methods of renovation and samples of oils, wastes, and packings representing renovated

journal box materials were secured from each of the member roads represented on the 1936 Specifications and Lubrication Committees, and the Southern Pacific. Samples representing 17 oils, 26 wastes, and 22 saturated packings were received from the Atchison, Topeka & Santa Fe; Baltimore & Ohio; Chesapeake & Ohio; Chicago, Burlington & Quincy; Chicago, Milwaukee, St. Paul & Pacific; Chicago & North Western; Chicago, Rock Island & Pacific; Delaware & Hudson; Illinois Central; Missouri Pacific; New York Central; New York, New Haven & Hartford; Northern Pacific; Pennsylvania; Southern Pacific, and Southern.

The samples were furnished in triplicate and analyzed in the A. T. & S. F., Mo. Pac. and N. Y. C. laboratories to determine the values of 14 items using methods commonly accepted as standard, previously agreed to or developed during the progress of the work. Some study of special apparatus for the analysis of saturated packing was made, but abandoned in favor of the method finally recommended. Detailed results of this survey were reported to the membership of the two committees under date of May 22, 1938, with recommendations for revision of the renovated car-oil specification as M-904-38, and a new specification for renovated journal-box waste and packing as M-910-38.

These specifications were recommended by the committees for circularization among the members of the Association as information, and were published in Circular No. DV-938, dated Chicago, August 26, 1938. Comments and criticisms received from the member roads through the secretary's office were studied at a meeting of your joint sub-committee on December 19, 1938.

The classification of the comments on the suggested revision of specifications M-904-38 for renovated car oil showed:

Roads in favor, or in favor with minor suggested modifications	28
Roads in favor in general, but suggesting deletions, changes, or additions	14
Roads against, or favoring retention of present specification M-904-36	15
Total number of roads making comments	57

The classification of the comments on the suggested new specifications M-910-38 for renovated journal-box waste and packing showed:

Roads in favor, or in favor with minor suggested modifications	39
Roads in favor in general, but suggesting deletions, changes, or additions	9
Roads against, or favoring the current specification (Rule 66)	8
Total number of roads making comments	56

Based on study of the comments and criticism received from the membership of the association, the specifications were revised and resubmitted to the members of the committees under date of December 22, 1938, as M-904-39, and M-910-39.

Further Investigations of Renovated Car Oil

The joint sub-committee's draft of specifications M-910-39 was approved by Specifications Committee at a meeting held January 11-12, 1939, but action on specifications M-904 was deferred and further investigation of "precipitants" and a study of the method of "ash" determination of renovated car oils in the laboratories of all members was authorized. The joint sub-committee submitted tables with this report setting forth the results of investigations of precipitant and ash determinations of renovated car oils conducted independently by each member of the Specifications Committee.

The General Committee in New York on June 27, 1939, deleted specifications M-904-39 from the 1939 report of the Specifications Committee and referred it back to the committee for further study and analysis. In accordance with this action, the joint sub-committee made a survey of the renovated car oils actually used by seven railroads and included in this report tables tabulating the check analyses by several railroad laboratories of duplicate samples of these oils.

A revision of the specifications for renovated car oil, suggested by the joint sub-committee with a recommendation for submission by letter ballot as specifications M-904-40, was attached to this report. In Section 5 (Properties and Tests) of the revised specifications were two foot-notes. The first pointed out that, because of the variations in solvent action with respect to tarry matter of A. S. T. M. precipitation naphthas from different sources and to assure the agreement in the results obtained by different laboratories, it is desirable that the reagent be obtained from one source, the Standard Oil Company of Indiana (Whiting Refineries). The second called attention to the fact that the difference, as between laboratories, in the determination of the "precipitation number" of a renovated car oil by A. S. T. M. method D-91 can be 0.05 per cent at the 0.25 per cent maximum value specified and, therefore, a precipitation-number determination of 0.30 per cent for any given oil would not be cause for rejection under these specifications.

Specifications M-910: Renovated Journal-Box Packing

Your joint sub-committee has carried out your instructions to consider the matter of placing some arithmetical limitation on the percentage of "short ends" permissible in renovated journal-box packing as suggested by G. W. Ditmore, a former chairman of the Lubrication Committee, in his communication of March 4 to the secretary, and referred to the committees with his file ST-10-910 of March 8, 1940.

The suggestion of the joint sub-committee for a revision of specifications M-910 to meet Mr. Ditmore's objections as made in the preliminary draft of the 1940 annual report dated April 4, 1940, was approved at the meeting of the Lubrication Committee on April 18, but, after consideration of reports of proof checks of method and determination of the actual percentage of "short ends" in renovated packings by several members of the Specifications Committee, as suggested in the chairman's letter of April 4, to the memberships, the revision of specifications M-910 to include the proposed limit for "short ends" was not approved and will not, therefore, be recommended to the association membership.

The report as a whole was signed by J. R. Jackson (chairman), engineer of tests, Mo. Pac.; P. Maddox, superintendent car department, C. & O.; A. J. Pichetto, general airbrake engineer, Illinois Central; L. B. Jones, engineer of tests, Pennsylvania; W. G. Aten, mechanical inspector in charge of lubricating matters, C. B. & Q.; J. Mattise, general air-brake instructor, C. & N. W., and J. W. Hergenhan, assistant engineer, test department, N. Y. C.

In presenting the report, Chairman Jackson called the attention of the members to the fact that the proposed revision of Specification M904-40, Exhibit "M," in the report, had been withdrawn by the committee for further study.

Report on Wheels

During the year there have been two meetings of the Wheel Committee in addition to meetings held by sub-committees detailed on various special subjects. As a result of the year's work your committee submits the following report:

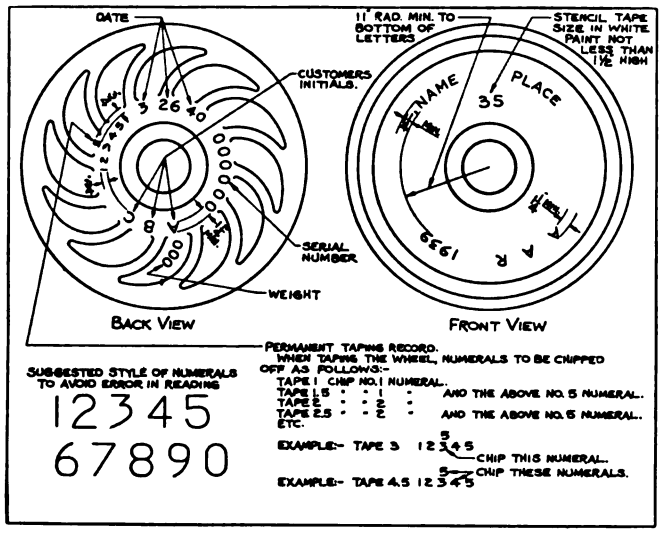
Cast Iron Wheels

In the 1939 Report of the Wheel Committee, Circular DV-959, a revision of the Cast Iron Wheel Specification M-403-39 was presented for consideration, the revised section of the specifications being attached as Appendix A. (Not included in the present abstract of the committee report.) It is now the unanimous opinion of the Wheel Committee that these revised specifications be advanced to standard with modifications as indicated below:

Sec. I. Manufacture

Par. 4. Marking—Revise to read: "All wheels shall be marked and numbered consecutively in accordance with instructions issued by the purchaser.

"All wheels shall bear the initials of the purchaser, weight of wheel, *serial number, tape indicating numerals,* and month, day and year when made cast on the back of the plate as shown in *Fig. 4.* All wheels shall have the name of the manufacturer and place cast on the front of the plate. Wheel numbers once rejected shall remain unfilled. All wheels conforming to require-



Marking required to be cast on the front and back of chilled-iron car wheels

ments of these specifications shall have plainly marked on the front of plate 'A. A. R. *1940*'."

In the foregoing revision, provision is made for applying the purchaser's serial number and the indicating tape numerals on the back of the plate. In the original design of the bracketed type, single plate wheel, this could not be done on account of the length of the brackets. The manufacturers have shortened the brackets and it is now possible to add this marking to the back of the plate.

Sec. III. Design, Dimensions and Weights

Par. 6.—Identify Par. (d) as Par. (e) and insert new Par. (d) to read as follows: *All ground wheels shall be stenciled on front and back of plate with tape size as measured after grinding for use in mating wheels for mounting. Cast numerals shall be chipped to represent "as cast" tape size.*

In Tables I, II and III, change maximum weight from 825 lb. to *850* lbs. In Table I, change minimum weight from 815 lb. to *840* lb. The reason for this recommended change in weights is, the wheels as now manufactured are weighing around 850 lb.

Sec. V. Inspection and Rejection

Par. 10.—Insert new paragraph designated as (e-4) to read as follows: *Wheels checked for out-of-round, where there is more than 1/32 in. space between ring gage and tread may be ground to conform to the specifications. Such wheels shall not be reduced more than two tape sizes and the taper 1 in 20 shall be maintained,* and then change present paragraph (e-4) to (e-5).

Bracketed Cored Hub Wheels

In the committee's 1938 report, reference was made to authority having been granted the Association of Manufacturers of Chilled Car Wheels to manufacture 10,695 lb. bracketed type, cored hub wheels for use on cars of 100,000-lb. capacity.

In conformance with the above authority the cast iron wheel manufacturers have made 3,200 wheels, distributed as follows: 800—under lightweight welded cars for the Pullman-Standard Car Manufacturing Company; 800—under 50-ton cars for the C. B. & Q.; 800—under 40-ton refrigerator cars for the General American Transportation Corporation; 800—under lightweight cars for Pullman-Standard.

There still remain unfilled on this authority for 10,000 wheels, 6,800 bracketed-type, cored-hub wheels of 695-lb. weight.

The Association of Manufacturers of Chilled Car Wheels requests that it be permitted to manufacture the remaining 6,800 wheels on this authority in the bracketed, cored hub type of any standard weight. This request is made that more general information may be obtained from this type of wheel when applied to various classes of service.

Your committee is favorable to this request, but if granted, it should be with the understanding that the manufacturers cast immediately under the AAR-X in clearly discernible letters the words "cored-hub." This requirement is recommended in order to readily identify the cored hub wheels and thus simplify the handling of such wheels in Interchange. These wheels shall conform to the requirements under which the authority was originally granted.

Cored Hub—Axle Strength

In discussing cast iron wheels with cored hubs in the 1938 report, mention was made of two conditions that might react unsatisfactorily to the use of this design, namely, the effect the cored openings in the hub surface might have upon obtaining a smoothly-machined surface in the bore of the wheel and the effect on the unsupported section of the hub might have upon the strength of the axle.

It has been reported that no serious difficulties have been encountered in boring the cored-hub wheels, but information is still lacking in regard to the effect the cored hub may have upon the strength of the axle. The Association of Manufacturers of Chilled Car Wheels advise it has a program of laboratory tests under way which tests are of a preliminary nature, but designed to develop information along the line of axle strength. It is anticipated that these preliminary tests will be supplemented with other laboratory tests using full size axles.

Multiple-Wear Wrought Steel Wheels

Referred to in and appended to the 1939 report was a Tentative Specification for Heat-Treated Multiple-Wear Wrought Carbon Steel Wheels for Locomotives, Locomotive Tenders and Passenger Cars. The membership has had the opportunity to apply the specification throughout the year and while it has been closely followed by some roads, others, due to the specifications not being published in the Manual of Standards, have overlooked it.

So far, no criticism has been registered against this specification. It is the opinion of your committee that under Sec. II—Chemical Properties and Tests—Par. 5—the maximum carbon content in Class-C wheels be revised from 0.80 to to *0.77 per cent* and under Sec. II—Par. 7 (b) a maximum hardness be established for Class-C wheels. This maximum hardness to be *363 BHN.*

With the above mentioned revisions it is the recommendation of the committee that the tentative specifications for heat-treated multiple-wear wrought carbon steel wheels for locomotives, locomotive tenders and passenger cars be submitted to letter ballot for advancement to standard practice. These specifications revised in accordance with the above are reprinted as Appendix B (not included in this abstract of the committee report).

Multiple-wear wrought steel wheel specifications M-107-37 and the tentative specifications covering multiple-wear wrought carbon steel wheels, in the section referring to "Scope," limits the application of the specifications to 38-in. diameter wheels. The use of wrought steel wheels in the process of locomotive development has created a demand for wrought steel wheels exceeding the present 38-in. diameter limit and recommendations have been made that the item "Scope" be revised at this time. At the time this report was prepared the committee had not received suggestions from the Locomotive Construction Committee as to what its wheel requirements may be and it was considered that revision of the "Scope" section of the specifications and associated items be deferred for consideration by the Wheel Committee during the coming year.

Shelling of Wrought Steel Wheels

The shelling of wrought steel wheels and tires represents a condition that is most destructive to the wheel and tire material. The shelled condition not only is objectionable from the standpoint of riding qualities, but the tendency of this condition to penetrate deeply into the material makes it especially destructive to the potential service of the wheel or tire where it occurs. Various theories as to the cause of tread material shelling have been advanced. The generally accepted theory is discussed in a recent booklet prepared by the Technical Board of Wrought Steel Wheel Industry. While the theory upon which this booklet is based is more or less technical the author in dealing with the subject has avoided as much as possible the technical side of the subject and treated it in such a manner as to be readily comprehended without the reader having to delve into the mathematics involved. As the subject treated in this booklet is so closely related to one of the major problems in wheel and tire

service your committee requested the privilege of making the contents a portion of this year's report, available as Appendix C (not included in this abstract of the committee report).

[This discussion of the shelling of wrought steel wheels, prepared by the Technical Board of the Wrought Steel Wheel Industry and presented as Appendix C, is an extension of notes included in the 1939 annual report. It is a comprehensive and easily followed analysis of conditions which lead to shelling and methods necessary for its prevention. The wheel is studied as an engineering structure and an examination made of (1) stresses under various load conditions, (2) the metal strength and (3) the application of (1) and (2) to the selection of proper wheel types for various service requirements. Appendix C describes methods of computing tread stresses, discusses the mechanical properties of wheel steel, and the effect of rail and wheel tread contours on maximum shear stress. It concludes with the calculations necessary in developing a series of charts giving surface stresses in compression and maximum shear stresses for varying wheel loads and wheel diameters.—Editor.]

Cast Steel and Spun Steel Wheels

The status of the cast steel wheel industry is somewhat uncertain and while there are a number of cast steel wheels of the one-wear type in service, information reaching your committee is to the effect that neither the one-wear nor the multiple-wear wheels are, at the present time, in production.

The spun steel wheel industry is still actively engaged in efforts to produce a multiple-wear wheel capable of meeting exacting service conditions. In line with this policy the manufacturers have placed small groups of spun wheels under conditions where their service properties can be best developed and encouraging results are reported.

It has been suggested that attention be given to a revision of interpretations under Rule 98 referring particularly to answers to Questions 5 and 6 under this rule. Your committee recommends that under the first line of answer to Question 5 the words "one-wear wrought steel" be omitted and the "or" inserted between the words "cast iron" and "cast steel." With this change the committee sees no occasion for any revision of answer to Question 6.

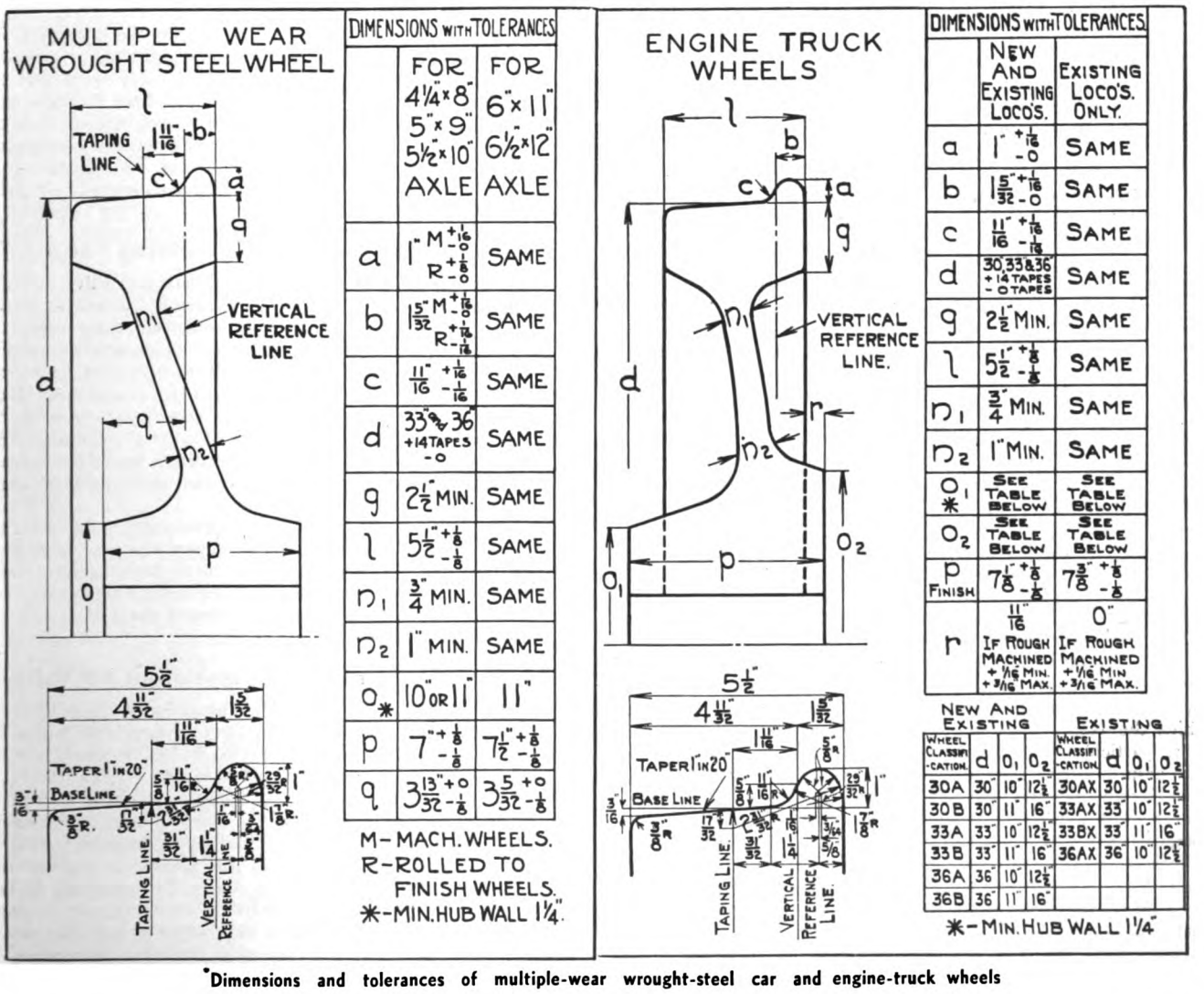
Cast Steel Wheel—Second-Hand Value

It has been brought to the attention of the committee that railroads handling cars equipped with one-wear cast steel wheels are coming in possession of second-hand wheels of this class with little or no opportunity for disposing of them. It appears that the one-wear cast steel wheel is no longer produced and its use is being discontinued by the railroads that formerly patronized it, it has also been stated that some of the railroads that formerly used one-wear cast steel wheels are substituting cast iron wheels and removing the cast steel wheel stenciling from the cars, thus making the cast iron wheel standard to the car. This practice is further limiting the opportunity for the disposal of accumulated second-hand cast steel wheels.

It is apparent that the chance for disposal of second-hand cast steel wheels accumulated in interchange is being more and more limited and your committee recommends that some protection should be afforded the railroads coming in possession of these wheels, through a revision of the second-hand value of one-wear cast steel wheels, making their values comparable with second-hand cast iron wheels of the same capacity, then revising the rules to permit one-wear cast steel wheels to be substituted for cast iron wheels at the second-hand value of cast iron wheels.

Wheel-Shop Practices

In order to better meet more exacting service conditions care-



DIMENSIONS WITH TOLERANCES		
	FOR 4¼"×8" 5"×9" 5½"×10" AXLE	FOR 6"×11" 6½"×12" AXLE
a	1" M +1/16 -0 R +1/8 -0	SAME
b	1 5/32" M +1/16 -0 R +1/16 -1/16	SAME
c	11/16" +1/16 -1/16	SAME
d	33" & 36" +14 TAPES -0	SAME
q	2½" MIN.	SAME
l	5½" +1/8 -1/8	SAME
r1	¾" MIN.	SAME
r2	1" MIN.	SAME
o*	10" OR 11"	11"
p	7" +1/8 -1/8	7½" +1/8 -1/8
q	3 13/32" +0 -1/8	3 5/32" +0 -1/8

DIMENSIONS WITH TOLERANCES	NEW AND EXISTING LOCO'S.	EXISTING LOCO'S. ONLY.
a	1" +1/16 -0	SAME
b	1 5/32" +1/16 -0	SAME
c	11/16" +1/16 -1/16	SAME
d	30, 33 & 36" +14 TAPES -0 TAPES	SAME
q	2½" MIN.	SAME
l	5½" +1/8 -1/8	SAME
r1	¾" MIN.	SAME
r2	1" MIN.	SAME
o1 *	SEE TABLE BELOW	SEE TABLE BELOW
o2	SEE TABLE BELOW	SEE TABLE BELOW
p FINISH	7⅛" +1/8 -1/8	7⅜" +1/8 -1/8
r	11/16" IF ROUGH MACHINED +1/16 MIN. +3/16 MAX.	0" IF ROUGH MACHINED +1/16 MIN. +3/16 MAX.

NEW AND EXISTING WHEEL CLASSIFICATION	d	o1	o2	EXISTING WHEEL CLASSIFICATION	d	o1	o2
30A	30"	10"	12½"	30AX	30"	10"	12½"
30B	30"	11"	16"	33AX	33"	10"	12½"
33A	33"	10"	12½"	33BX	33"	11"	16"
33B	33"	11"	16"	36AX	36"	10"	12½"
36A	36"	10"	12½"				
36B	36"	11"	16"				

*Dimensions and tolerances of multiple-wear wrought-steel car and engine-truck wheels

ful consideration is being given to materials and designs in the construction of car equipment which includes both wheels and axles. In dealing with the question of wheels and axles another factor that is as equally important as material or design, is the manner in which these two units are combined, or the wheel-shop practices followed in mounting.

The unsatisfactory manner in which some wheels and axles have been mounted can be readily observed in practically any active wheel shop by noting the condition of wheel fits on the axles and the bore of wheels as disclosed when they are dismounted in connection with wheel-shop processes.

Again, your committee wishes to emphasize the importance of providing adequate wheel-shop machinery and then demanding closer observance of methods that will produce a greater degree of refinement in the preparation of wheels and axles for mounting.

The report was signed by H. W. Coddington (chairman), chief chemical and test engineer, N. & W.; D. Wood (vice-chairman), engineer tests, Sou. Pac.; E. E. Chapman, mechanical assistant, A. T. & S. Fe; W. R. Hedeman, engineer of tests, B. & O.; J. Matthes, chief car inspector, Wabash; A. M. Johnsen, engineer tests, Pullman Company; E. C. Hardy, assistant engineer, N. Y. C.; A. G. Hoppe, assistant mechanical engineer, C. M. St. P. & P.; H. H. Haupt, general superintendent motive power, Penn., and C. B. Bryant, engineer of tests, Southern.

Discussion

Following the presentation of the report by Chairman Coddington, F. J. Jumper, general mechanical engineer, Union Pacific, read a prepared discussion in which he described Union Pacific experience with thermal cracking or checking and shelling of wrought-steel wheels under the exceptionally severe conditions of modern high-speed passenger-train service. He attributed the difficulty largely to overheating of the wheels in heavy brake applications and the subsequent sudden cooling on the cold rails or by the application of snow or water. These difficulties have now been largely overcome by the use of heat-treated steel wheels with a carbon content ranging between .57 and .67, and a minimum Brinell hardness of 277. Mr. Jumper said that important factors in satisfactory wheel service and life include ground treads, brake rigging of proper design, square truck frames and journal boxes designed for free vertical movement without binding.

C. T. Ripley, chief engineer, Technical Board, Wrought-Steel Wheel Industry, complimented the committee on its report and said that the carrying out of its recommendations will promote safety, benefit shippers and save the railroads money. Both wheel manufacturers and the railroads must cooperate in effecting improvements necessary to meet the more difficult operating conditions attendant upon high speeds. Mr. Ripley said that research for wheel improvements must be continuous and that, on account of the increased severity of the service, the day has passed when any single steel wheel can be expected to meet satisfactorily the requirements in every class of service. Wheels must be selected with regard to the types best adapted for particular conditions, as pointed out in the committee's report.

Mr. Ripley paid tribute to the general ability, intelligence and loyalty of men employed in wheel shops and suggested that, when unsatisfactory wheel and axle work is discovered, it is usually due to the lack of proper shop equipment. In other words, with machining tolerances of .005 in. now being demanded and attained in wheel-shop work, micrometer tools and calipers are essential, and desired results cannot be expected even with the most competent and experienced wheel-shop forces if they are compelled to work with obsolete worn-out shop tools.

F. H. Hardin, president, Association of Manufacturers of Chilled Car Wheels, endorsed Mr. Ripley's comment regarding the large amount of intensive and thoroughly competent work which the Wheel Committee has incorporated in its report this year, particularly as relates to those recommendations which will assure increased reliability and longer life of car wheels. Mr. Hardin said that, owing to substantially higher freight-train speeds and the increased severity of operating requirements, carefully selected materials and fine workmanship are just as essential in wheel and axle assemblies in freight-car trucks as for those used in passenger service. Mr. Hardin also stressed the need for further improvements in wheel-shop practice and said that the railroads are cooperating fully with his association in securing improved service from chilled-iron car wheels.

There was some further discussion of the desired minimum carbon content in steel wheels used for high-speed passenger service and also the method of heat treating necessary to produce the best results.

The report was accepted and necessary items referred to letter ballot.

Report on Brakes and Brake Equipment

Since the last annual report there have been two meetings of the full committee and a number of sub-committee meetings covering investigation of various items under consideration, many of which are still incomplete, and we submit the following for your consideration at this time.

Air Hose Couplings

The question of suitable gages for checking used couplings, methods of reclaiming or servicing hose couplings, has been before us for some considerable time and while the solution may have appeared simple at first glance, it is not to be so readily solved. Much time has already been given it with considerable progress, and we hope to have definite recommendations to submit in the very near future.

Standard Brake Beams

In our report last year we promised you that our recommendations would be forthcoming in the very near future for a No. 3 or No. 18 brake beam, but we regret to say that we have not yet completed all the details in connection with this design because many such details now seem to involve the present standard No. 15 beam in which interchangeability and further standardization of certain parts that may be used for both the No. 15 and No. 18 beams seems possible, and, of course, desirable, and some further study is necessary.

On numerous occasions your committee has been pressed for its approval of reversible struts of one kind and another comprising two or more parts. We have examined many types and designs of such struts over a period of years and we are in accord that they are undesirable in one or more features they embody, and that any merit they may possess seems entirely outweighed by the disadvantages introduced by their use. We therefore do not approve of any reversible struts employing two or more component parts.

Modification of Freight Retaining Valve

The question of redesigning the freight retaining valve in order to provide additional protection and variable control of brake cylinder pressures was acted upon by a sub-committee and a report submitted at our last regular meeting, which was accepted in general. However, a difference of opinion prevailed as to the most desirable size of the orifice openings and rates of blow down for the various grade operations encountered in nation-wide operation. It seems necessary to confer further with the manufacturers and to also determine by individual observation under the various operating conditions what dimensions and rates may be most satisfactory.

Applications of the molded rubber sleeve and the latest design of wasp excluder recommended in our report last year have been made but we are not yet in a position to make a definite statement as to their entire satisfaction. To date we have no unfavorable comments in respect to them and the indications are that they provide the protection desired.

Cleaning, Testing and Lubrication of AB Valves

You will recall that from previous inspections of experimental AB brake equipment in service on Pennsylvania and Santa Fe cars it was decided at the last inspection in 1937 to equip a number of these cars with improved design of brake-pipe strainer in view of the fact that previous tests of these strainers seemed to indicate there was a possibility that very minute particles of foreign matter may in time filter through the strainers and get into the valves. The manufacturers had previously realized this and were at that time prepared to supply the improved design. Your committee was also convinced they were superior in every way, but to definitely determine as to whether or not they would be entirely satisfactory throughout at least a three year period in actual service, they were applied to these cars. These strainers

have now been in service three years and arrangements are under way to make the necessary inspection and tests similar to those previously made.

Reclaimed or Reworked Brake Beams

In the reclamation of brake beams it has been the practice on some roads to apply hardened bushings to the pin hole in the brake-beam strut. It is our recommendation that this practice is only satisfactory with existing struts providing there will be not less than 3/16-in. wall thickness at any point of the boss surrounding the pin holes after the holes are drilled out concentric with the original pin-hole center to 1½-in. diameter and that the bushings are a tight pressed fit.

With respect to the new struts for the standard No. 15 beams, it is our recommendation that the strut dimensions given on Page 91 of Section E of the A. A. R. Manual be revised to show sufficient material surrounding the pin holes to provide ample strength at this area when the pin holes are drilled to 1½-in. diameter.

Stencilling of Cleaning Dates for AB Brakes

Due to the extended service period of AB brakes over those of the "K" equipment your committee is in accord with the Arbitration Committee's opinion that the stencilling of cleaning dates may not always remain legible throughout the allotted service period where the stencil is applied as shown on Page 123 of Rule 60, Code of Interchange Rules. We see no objection to the stencilling being applied on the side of the car at, or as near, the center of the car as practicable, or any other location that will insure it being legible at all times.

We are also in accord with the suggestion in reference to deleting the last sentence in Paragraph (h) of Interchange Rule 60.

Lubrication of Air Brakes

Supplementary to our recommendation last year in this connection in which reference was made to the need for approved lubricants for air-brake valves and cylinders, your committee is convinced it is imperative that the AB brakes be lubricated only with tested and approved lubricants in order to insure satisfactory performance throughout the longest possible service period, and specifications for oil or air-brake valves, graphite for air-brake valves, and grease for air-brake cylinders are recommended for your approval as the approved and standard lubricants to be used. [These specifications were included in this report.—EDITOR.]

Changes in Construction of AB Brakes

Certain minor changes have been introduced in the AB equipment since it was originally introduced into service that have very definitely improved their performance and service life. The items affected are:

Quick-action-chamber charging choke, piece No. 506277; brake-pipe strainer, piece No. 502904; emergency-piston spring, piece No. 501006; Reservoir release-valve end plate, piece No. 54963 and, wasp-excluder barrier in the quick-service vent passage, piece No. CV-276.

It is our recommendation that improved parts covered by the above mentioned piece numbers be substituted for those of previous designs and piece numbers as AB valves are given periodical attention in accordance with Interchange Rule 60.

The report was signed by W. H. Clegg (chairman), general superintendent motive power and car equipment, Grand Trunk Western; R. E. Baker (vice-chairman), general air-brake inspector, Boston & Maine; T. L. Burton, air-brake engineer, New York Central; C. H. Rawlings, superintendent of air brakes, D. & R. G. W.; L. S. Ayer, general air-brake inspector, Sou. Pac.; R. J. Watters, general air-brake inspector, Nor. Pac.; J. A. Burke, supervisor air brakes, A. T. & S. F.; Otta Swan, air-brake instructor, Union Pacific; J. P. Lantelme, general foreman, Pennsylvania; J. Mattise, general air-brake instructor, C. & N. W., and R. E. Anderson, general air-brake inspector, C. & O.

Discussion

In presenting the report, Chairman Clegg called attention to the oxidization test in the Oil Specifications, exhibit A, and to the Graphite Specifications. These, he said, should be referred to the Committee on Specifications and Tests for their approval.

The chairman of the committee was asked to explain what are the disadvantages of the two-part brake-beam strut, which the committee did not approve, and Mr. Clegg replied that the two-part reversible brake accumulates lost motion in service and results in the development of too much flexibility in the brake beam. T. L. Burton, a member of the committee, explained further that a strut between a compression and a tension member was partly in compression and partly in tension and that under such conditions, nothing but a solid member could fully retain its effectiveness.

The report was accepted and referred to letter ballot.

Report on Couplers And Draft Gears

Type E Couplers Breaking in Service

Acting upon information received that Type E couplers were breaking in service, an investigation was made of this condition by the members of the committee and also by the Mechanical Committee of the Coupler Manufacturers. An examination was made of 244 broken couplers, 221 of which were cracked or broken through the front face and 162 had received a heavy impact on the guard arm.

The committee, through its analysis, is unable to assign car design, coupler or attachment design, material or foundry practice as a factor in this problem. It has had no opportunity to investigate the service conditions under which these failures are occurring, but the face-breakage failures and broken-off guard arms are occurring in the transportation yards. The heavy impact on the guard arm is evidence that the speed at time of coupling is too great and that couplings are attempted with knuckles not fully opened. The correction lies in reducing speed to 2 m.p.h. at the time of coupling and insuring knuckle or knuckles being fully opened before coupling is attempted.

Top Lock-Lifter Link Hook of Type E Coupler Straightening Out in Service

Under certain conditions of wear, the straightening of the top lock lifter link hook is possible. This condition was taken care of by a redesign of the top lock-lifter link for the Type E coupler which has been approved by your committee and the change in design was put into effect, December, 1939.

Train Partings of Standard Type E Couplers

During the year, it has come to the attention of your committee that some train partings have occurred between new cars built in 1936 and 1937 and equipped with standard Type E couplers. It has also been reported that standard Type E couplers have been found with bottom lock lift toggles missing and in an inverted position. In either case the coupler lock would be deprived of its anticreep feature. This condition was immediately brought to the attention of the Mechanical Committee of the Coupler Manufacturers, and a thorough investigation and study has been made of these conditions.

To eliminate these conditions, proposed changes in the several types of rotor levers and the toggle consist of a redesign on the basis that one end of the rotor lever in each case is provided with a jaw into which the toggle is fitted and retained definitely in this assembled position by means of a rivet. In the passenger Type No. 1 arrangement, the rotary lock lifter link is also riveted to the rotary lock lifter lever. The new design of rotor lever and toggle will be furnished completely assembled and riveted together. These proposed changes in the several bottom rotor levers and the toggle will affect the design of the present standard gages. The gages will therefore be changed in accordance with the changes affecting the above coupler parts.

Your committee at its meeting on February 19, 1940, at Cleveland, approved the above proposed changes in design of the bottom-rotary lock lifter and toggle and recommended that gages for properly checking this revised design be prepared and put into service for the Type E coupler. These changes became effective in the fitting of new couplers and for repair parts by all coupler manufacturers about June 1, 1940, and do not require any alteration in the uncoupling rods.

It is to be understood that to date very little trouble has been experienced from these toggles either missing from couplers in service or improperly applied on account of any wear that has thus far taken place. The improvements herein presented are for the purpose of correcting any conditions that may be encountered in the future and to improve the design of the E coupler mechanism.

Type D Couplers Opening in Service

On May 13, 1938, Circular DV-935 was sent out to the membership calling attention to means for preventing separation of bottom-operated Type D couplers in passenger service by application of the No. 3 lock lift toggle. Since that time, this condition of trains parting with Type D couplers seems to be relieved in passenger service, but information has reached your committee that separations are occurring on top-operated Type D couplers in freight service. There are two conditions in freight service that may contribute largely to the opening of these Type D couplers. Indications are that the most prominent factor in these train partings is the use of push-down-type operating levers. The other condition responsible for top-operated Type D couplers coming open occurs in couplers to which the No. 3 top lock lifter has not been applied, or the No. 2 top lock lifter not built up on the anticreep to conform to the No. 3 design.

The committee again emphasizes the importance of maintaining the No. 3 type of lock lifter in top-operated and No. 3 toggles in bottom-operated Type D couplers in order to prevent train partings caused by couplers of this type opening in service.

Types D and E Couplers—Fully Locked Position

The question has been raised as to the method of determining when Types D and E bottom-operated couplers are in the fully locked position.

In order to demonstrate this condition, Fig. 1 was prepared to show the Types D and E couplers in the lock-set position and in the fully locked position. It will be noted that in the Type D coupler in fully locked position, the bottom of the lock extends slightly below the bottom of the coupler head, and the toggle is practically fully visible. In the Type E coupler in fully locked position, the bottom of the lock is approximately flush with the bottom of the head and the greater portion of the toggle is visible. (The diagram is not included in this abstract.)

Reclamation of Draft Key and Knuckle Pins

The secretary has referred to this committee two items relative to reclamation mentioned in Circular D-VI-483. One of the topics in question relates to condemning draft keys. To date, the committee has insufficient information to establish definite condemning limits for wear for draft keys but proposes to do so during the coming year. Where the keys have worn to any appreciable extent some roads in their rebuilding program make it a practice to restore the width of the keys by either upsetting or fullering the keys longitudinally.

Fig. 2 shows a method of reclaiming these draft keys and is included in this report as a guide. The limits given will be subject to review when definite limits are established for keys reclaimed.

The other item referred to this committee is the method of straightening knuckle pins and the heat treatment necessary for reclaiming pins. This process is clearly prescribed in the A. A. R. Manual of Standards and Recommended Practice, Section C, Page 68, Item 4, Paragraph (b).

Yoke Substitute for Odd-Length Gear Pockets

A study has been made toward the development of a horizontal key type coupler yoke that might be used as a substitute for the riveted type yoke or non-standard design of cast steel yoke. The type of yoke that appears to best meet this condition is a combination of cast-steel head and forged yoke straps, as shown in diagrams submitted with this report. (The diagrams are not included in this abstract.)

The use of a yoke of this type would enable repairs to be made without having to carry in stock yokes of a variety of lengths. The cast-steel heads can be carried in stock and straps of the proper dimensions riveted to the head. It is the opinion of your committee that this type of construction will facilitate repairs and the design is presented with the recommendation that the proposition be submitted to letter ballot.

Specifications for Second-Hand Couplers

Included in the committee's annual report for 1937 were specifications for second-hand couplers. These specifications were adopted as recommended practice in 1937 and it is the recommendation of your committee that these specifications be advanced from recommended to standard practice. It is further recommended to the Arbitration Committee that Section 4 of the second-hand coupler specifications, prohibiting the painting of second-hand couplers, be made mandatory through the Interchange Rules.

The Arbitration Committee has recommended "that the requirement for coupler body to be steel stamped on the side of the lock chamber when it contains one or more reclaimed parts, be eliminated, for the reason that these parts may be removed within a short period of time and new parts applied. Furthermore, the rules require stamping on or adjacent to any welded portion of the coupler body, in which event many couplers thus carry two steel stampings."

The Arbitration Committee further states that it is inconsistent to place a requirement in the Interchange Rules to prohibit the painting of reclaimed or second-hand couplers when no such prohibition is provided for truck sides. These recommendations were carefully considered by your committee and it does not concur in them.

The present requirements were incorporated in the Rules to protect car owners and after reviewing the matter, your committee is of the opinion that no change should be made in these requirements to insure that second-hand couplers are properly reclaimed and where coupler bodies are welded in the knuckle side wall that the work will be properly performed. There is no further requirement in regard to the welded detail parts that may be applied to couplers in repairs.

Insofar as prohibiting the painting of second-hand couplers, your committee believes that this is a proper requirement so that proper inspection may be made of the welding that has been done, and is consistent with the requirement for new couplers which are not permitted to be painted. Subsequent painting of the coupler by the car owner does not affect these specifications.

Interchange Rule 18—Paragraph (c)

The Arbitration Committee has recommended that the limiting

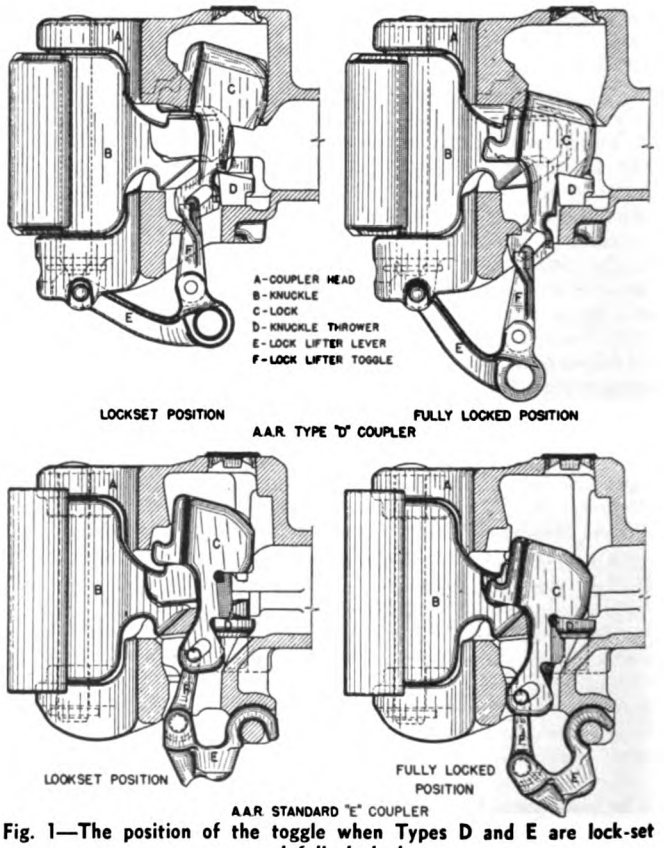
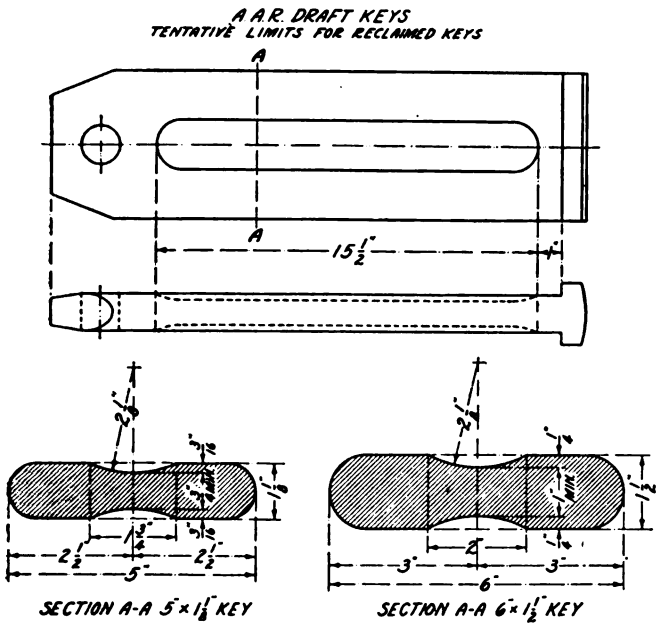


Fig. 1—The position of the toggle when Types D and E are lock-set and fully locked



Keys to be heated to forging temperature when making impressions. Size of impressions may vary but must not exceed dimensions shown. Restored keys to be quenched and tempered. Letters *H. T. S.* to be replaced on butt end of key with a $^3/_{16}$-in. stamp when original letters are illegible.

Fig. 2—Method of reclaiming draft keys

dimensions for cracks in the shaded area in the knuckle side wall which do not warrant removal of couplers from service be extended from 7½ in. to 10 in. in length and from 3 in. above and 3 in. below center line to 4 in. in both instances, measured on the surface of the coupler.

This recommendation was considered and approved by your committee for condemning limits for couplers in service. It is, however, not recommended to extend the present reclaiming limits as now provided for in the Rules for the reason that cracks of the magnitude proposed for condemning the coupler cannot be satisfactorily reclaimed on account design of the coupler head. In order to clear up another point, in regard to the measurement of the cracks, it is suggested that these cracks be measured on the surface of the coupler.

The following change in Rule 18, Par. (c) is suggested to cover this matter:

Proposed Form—Coupler bodies, Types D and E, with cracks in knuckle side wall back of knuckle tail shall not be removed from foreign cars, unless—

(1) Such crack extends beyond the shaded area shown in Fig. D, page 57 (*4 in.* above and *4 in.* below the horizontal center line of knuckle side wall and *10 in.* back of front edge of knuckle side wall). *These cracks shall be measured on the surface of the coupler.* When crack extends beyond the shaded area, the coupler body is condemned. (2) Section is broken out within this prescribed area whose greatest dimension exceeds three inches. (3) *Coupler bodies must not be reclaimed by welding if the crack extends more than 3 in. above and 3 in. below the horizontal center line of knuckle side wall; or 7½ in. back of front edge of knuckle side wall; or section is broken out whose greatest dimension exceeds 3 in.*

Tight-Lock Couplers

During the year, trouble developed with tight-lock couplers parting in service. Your committee in cooperation with the Mechanical Committee of the Coupler Manufacturers made a thorough study and analysis to establish the cause.

It was found that these partings generally occurred during wet weather and it was difficult to reproduce the partings on the same couplers after they had occurred in service. The cause for parting was finally determined to be due to the secondary anti-creep being ineffective when there was a sudden impulse for the lock to lift particularly when the parts were wet or lubricated.

Changes were made in the contour of the secondary anti-creep ledge and the engaging toggle, and model and laboratory tests made to determine whether positive corrective action had been taken, followed by road tests in the New York Central yards at Cleveland, O., with the result that it was impossible to obtain undesired partings with couplers wet and lubricated. These tests were severe and several couplers other than tight-lock couplers were fractured during these tests. As a result of the analysis and tests conducted, Circular D.V.-977 was issued April 3, 1940, covering instructions for making adjustments to improve lock anti-creep to prevent parting in service.

Attention is directed to the necessity of making the adjustments to the tight-lock couplers in service or in stock on the railroads at the earliest practicable date, and discontinue the use of an "S" hook, or bolt, through the telltale hole in the toggle, as the use of such hooks or bolts prevents operation of the coupler by means of the uncoupling rod and is a violation of the U. S. Safety Appliance Rules.

The changes involved in the coupler consists of: (A) Change in contour of the secondary anti-creep ledge in the bar to provide for positive engagement of the anti-creep shoulder on the toggle. (B) Redesign of the toggle to improve the angle of and enlarge the secondary anti-creep shoulder. (C) Adjustment in the primary anti-creep shoulder at the front of the lock to improve the engagement of the primary anti-creep shoulder at the front of the bar, and also to assist the positive engagement of the secondary anti-creep.

These changes were authorized by your committee as it was essential to take immediate action and your approval of these changes is respectfully requested as it is not considered necessary to submit them to letter ballot.

Specifications for Tight-Lock Couplers

Specifications for the purchase and acceptance of A. A. R. tight-lock couplers and coupler parts, radial connections, yokes, and attachment parts were appended to this report. It is recommended that these specifications be submitted to the Committee on Specifications for Materials for approval and then included in the letter ballot for adoption as recommended practice.

Protection of Coupler Operating Mechanism

It has been brought to the attention of your committee that some undesired uncoupling of passenger cars in service has been experienced due to objects striking the uncoupling rod handle or the bail to the uncoupling mechanism, and considerable study has been given to determine the best method to prevent this.

Jointly with the Mechanical Committee of the Coupler Manufacturers, your committee is working on a means for locking the operating lever and also a means for locking the bail to the uncoupling mechanism to the end that if anything strikes either the operating lever handle or the bail in transit uncoupling will not occur.

The locking of the uncoupling rod at each side of the car and of the bail to the uncoupling mechanism presents difficulty in design for which a solution has not yet been found. It is confidently expected that if the coupler operating mechanism is confined to one side of the end of the car, a satisfactory locking device could be readily developed.

While a number of designs have been evolved to accomplish the desired result, no conclusion has been reached to warrant your committee making any definite recommendation at this time. The committee solicits suggestions from the membership and will appreciate it if the representative members of the individual railroads will give to the committee the benefit of any recommendation they may have to make to overcome this reported trouble.

An expression from the membership is desired in regard to operating the coupler from one side of the car only, similar to freight cars. If the type of rod operating from one side of the car is satisfactory, your committee believes that an efficient locking device can be presented.

Report of Sub-Committee on Draft Gears

Approved Draft Gears: During the past year a conditional certificate of approval was issued for the Waugh-Clark 150-B draft gear. This brings to twelve the total number of draft gears approved to date, two of which are conditional approvals.

Attention is again called to the fact that conditional approvals are good for two years only, at the end of which time the gear may be advanced to fully approved status provided the service performance has been satisfactory. However, if the manufacturer involved already has an approved gear designed for the same pocket dimensions as the gear newly advanced to approved

status, one of these gears must be withdrawn and placed in the non-approved classification.

Several changes of minor character have been made in the official drawings identifying the various approved draft gears during the past year.

Check Tests of Approved Draft Gears: As a result of the check tests of approved draft gears, which were described in last year's report, a complete new approval test of one draft gear and a partial retest of another approved gear have been required. If these gears do not meet these tests, or if the manufacturers fail to submit the gears for retest within a reasonable time, existing certificates of approval will be withdrawn. The attention of all manufacturers was directed to the specific details wherein the gears submitted to check tests were below requirements. Car owners who have applied conditional approved draft gears will not be required to remove such gears from service if the approval status of gear is changed.

Since the first series of check tests showed that some new gears did not fully meet specification requirements, authority has been obtained to conduct another series of check tests within the present calendar year.

Draft Gears for Passenger Service: The committee submitted last year for comments and criticism proposed specifications for draft gears for passenger service. Since no comments were received, the secretary, under date of March 20th of this year, issued a circular letter to the members urging that comments or criticism be offered. Up to date of preparation of this report replies have been received from a total of thirty-four railroads.

There appears to be a strong feeling that any attempt to fix more or less arbitrary standards for passenger equipment draft gears at this time is somewhat premature, inasmuch as entirely new designs of gears are being introduced. Therefore, your committee has decided to make no recommendation for the present.

New York Central Recoil Tests: Several times during past years this committee has recommended that road tests be conducted by the association for the purpose of determining the effect of draft gear recoil in long freight trains. Present specifications for approved draft gears for freight service include no limit on percentage of recoil for the reason that no generally acceptable evidence exists to show what maximum percentage of recoil ought to be permitted under present day operating conditions.

During the past year the New York Central undertook to conduct such tests, and they were witnessed by the sub-committee. Two similar 100-car trains were used, one of which was equipped throughout with relatively high recoil gears, and the other with relatively low recoil gears. Both gears were approved types. Use of the brakes was limited to service applications.

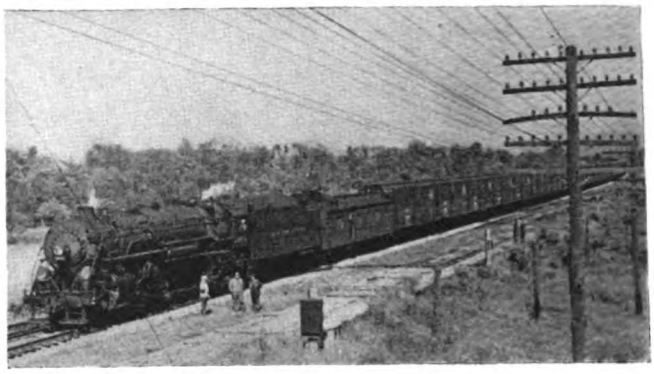
The results of these tests were not conclusive insofar as the effects of recoil were concerned; however, some interesting facts were disclosed and permission has been obtained to include as Appendix "A" of this report a condensed summary of the New York Central report for the information of members of the Association.

Appendix A—Recoil Tests

Object—The purpose of the tests was to determine the handling characteristics of a 100-car freight train equipped throughout with low recoil draft gears, Type X, as compared with a similar train equipped with relatively high recoil gears, Type Y, when subjected to service slow-downs and stops using various combinations of brake applications and grades intended to develop maximum train shocks.

Test Runs—Two test runs were made on the New York Central from Rochester, N. Y., freight yards to Gardenville, N. Y., freight yards, a distance of 65 miles, using the main line from Rochester to Chili Junction, 13 miles, and from there over the West Shore to Gardenville. The first test run was made September 20, 1939, with a train consisting of locomotive 2856, dynamometer car X-8006, 100 empty N. Y. C. box cars equipped with Type X draft gears, and a caboose. The total weight was approximately 2,410 tons. The second test run was made September 22, 1939, with a train consisting of locomotive 2851, dynamometer car X-8006, 100 empty N. Y. C. box cars equipped with Type Y draft gears, and a caboose. The total weight was approximately 2,390 tons.

A program of test stops and starts was developed during the first run with a view to producing maximum shocks without using emergency brake applications. This program was duplicated as nearly as possible with the second train.



One of the draft-gear-recoil test trains

Description of the Test Trains—The equipment of the two trains was identical as far as it was practicable to control it, the only major difference being the draft gears on each group of 100 box cars. All of the box cars had been selected from a lot recently converted from wood superstructure, steel underframe, to steel-sheathed body type by Merchants Despatch, Inc., at East Rochester, N. Y. None of them had been in service before these runs were made. The brake-cylinder piston travel for each car was approximately 7 in. and the braking ratio was approximately 58 per cent. There was no measurable brake-pipe leakage for either of the two trains.

The total slack in the train equipped with Type X draft gear was measured as 14 ft. 8 in., which amounts to 0.88 in. (about 7/8 in.) per car end, and for the train equipped with Type Y draft gear it was measured as 17 ft., which amounts to 1.02 in. per car end. It is believed that this difference in slack between the two trains is largely due to inaccuracies resulting from the method of measurement, which consisted of bunching and stretching the train and measuring the total travel. It may also represent a difference in lost motion between the coupler knuckles of the two trains, for no detail measurements of coupler slack were made. New and second-hand coupler knuckles were used when rebuilding these cars, but the proportion of each applied to the cars involved in these tests was not recorded.

Recording Instruments and Apparatus—The locomotive was equipped with a Valve Pilot to indicate speed and cut-off, and the brake valve was fitted with an electrical actuating device to record brake-valve action on dynamometer car chronograph. Brake-pipe pressure reductions were recorded from the gage on the locomotive.

In the dynamometer car, draw-bar pulls and buffs, speeds, distance, locations, time and locomotive brake-valve actuations were recorded. In the dynamometer car, and in four cars, the twenty-fifth, the fiftieth, the seventy-first and the one hundredth box cars from the head end of the train, Symington-Gould tumbling-block lading dynamometers were attached to the floor of the cars to measure shocks imposed on the cars. In addition, the fiftieth car carried two Redhed and one Westinghouse Air Brake Company's recording accelerometers.

Each tumbling block instrument contained a number of blocks arranged to tip over under various degrees of shock. The individual blocks are designated by numbers representing the acceleration in per cent of gravity required to tip over the block.

Test Procedure—Brake applications were made under various conditions of speeds and grades, with a view to developing maximum shocks with service brake applications. Starts were made with and without taking slack.

In the first three tests, brake applications with various brake-pipe reductions were made to ascertain the behavior of the train. For the later tests, brake applications were chosen with a view to producing maximum train shocks with service brake applications.

Test Results—The accelerations shown by the tumble-block dynamometers in various positions of the train are summarized below:

In the three preliminary tests (Nos. 1, 2 and 3) no blocks were tipped over. The greatest shocks were registered in Tests Nos. 6 and 8. In Test No. 6 stop was made with 25 lb. per sq. in. brake-pipe reduction at 15 m. p. h. on a 0.38-per-cent rising grade. The locomotive brake was applied at the same

time as the train brake. In Test No. 8 stop was made with 25 lb. per sq. in. reduction at 20 m. p. h. on a down grade of 0.25 per cent. The locomotive brake was applied five seconds after the train brake.

The only other braking tests in which blocks numbered higher than 20 tipped over were Nos. 9 and 11. In Test No. 9 at 15 to 17 m. p. h. on a 0.25 per cent descending grade the throttle was closed and the locomotive brakes applied. Five seconds later the brakes were released and the throttle opened wide. In Test No. 11 at 11 m. p. h. on level track a stop was made with a 25 lb. per. sq. in reduction. The locomotive brake was applied at the same time. In starting and taking slack, blocks of higher value than 20 were tipped over during only three sets of starts.

In all cases no acceleration is recorded for car 71 in any of the tests. Slight shocks were felt, but this car had no tumbling block with a value lower than 100. In the dynamometer car no tumble blocks were tipped over during the test runs. The records obtained with the Redhed and the Westinghouse accelerometers were in line with results obtained with the tumble-block dynamometers, but do not add any information of special interest.

The tests were carried out under the supervision of E. L. Johnson, assistant chief engineer of motive power and rolling stock, New York Central, and H. W. Faus, engineer of motive power, New York Central, and were witnessed by members of the A. A. R. sub-committee on draft gears.

Conclusions—No excessive shocks were produced, with the result that practically no difference in handling was observed between the two trains under the conditions of the tests.

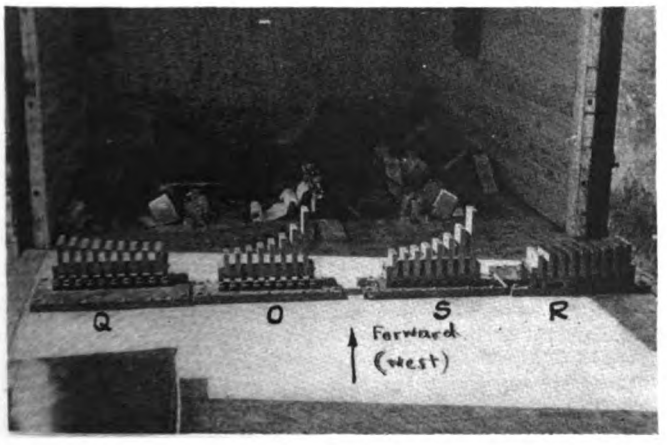
Neither of the two types of draft gears tested gave any indication of any action which might be considered as prejudicial to the use of the gears in regular service.

The fact that the highest value lading block to tip over during these tests was only 60 per cent g., indicates that the maximum force exerted on the draft gear of any instrument car was approximately 29,000 lb. Since this is less than the initial compression under which both types of gears are assembled, this leads to the conclusion that the forces set up in this train were not sufficient to cause the draft gears to function in such manner as to make it possible for them to exert any recoil.

The report as a whole was signed by R. L. Kleine (chairman), assistant chief motive power-car, Pennsylvania; H. W. Coddington (vice-chairman), chief chemical and test engineer, N. & W.; E. E. Root, chief motive power, D. L. & W.; L. P. Michael, chief mechanical engineer, C. & N. W.; J. P. Morris, mechanical superintendent, A T. & S. F., and H. W. Faus (chairman, subcommittee on draft gears), engineer motive power, N. Y. C.

Discussion

H. W. Gilbert, National Malleable & Steel Castings Company, stated that the coupler manufacturers have endeavored to cooperate in improving coupler design and service, and that their efforts in this direction can be rendered more effective if the railroads will supply the manufacturers Mechanical Committee, of which he is chairman, with full information regarding all coupler defects as they are developed. The Mechanical Committee must have representative samples which will illustrate conditions in order that proper corrections and improvements in design may be effected.



Tumbling-block dynamometers in the fiftieth car from the head end—Recording accelerometers are in the background

P. P. Barthelemy, master car builder, Great Northern, referred to the drawing of the cast-steel head used with the A. A. R. wrought-iron yokes and raised the question if the holding power of the rivets should be supplemented by welding the yoke ends to the coupler head. Chairman Kleine replied that this is not considered necessary, since the rivets are in double shear.

R. G. Henley, superintendent motive power, N. & W., suggested the use of a filler ahead of the yoke to prevent couplers from drooping and raised the question if the coupler should not be designed for satisfactory coupling at speeds up to 4 m. p. h. instead of 2, as specified in the committee report, inasmuch as draft gears are designed to meet the higher speed requirement. He expressed appreciation for the committee's action in extending the condemning limit for cracked side walls because a few railroads have been taking advantage of this rule to remove couplers which should not be removed. Mr. Henley said that a record of coupler breakages indicates that 95 per cent of the damage is done in hump-yard switching.

Chairman Kleine replied that the yoke head, coupler butt and key are designed with close tolerances so as to reduce slack and prevent the coupler from drooping. While car impact speeds up to 2 m. p. h. are recommended for satisfactory coupler closure, Mr. Kleine said that couplers will not necessarily fail when striking a speed up to 4 m. p. h., as a substantial factor of safety is included in the design. He maintained that the question of speed in hump-yard switching is a matter of regulation and may be reduced to 2 m. p. h. at the moment of impact without slowing up yard operation.

This opinion was challenged by D. S. Ellis, chief mechanical officer, C. & O., and by K. F. Nystrom, mechanical assistant to the operating vice-president, C. M. St. P. & P., and supported by E. B. Hall, general superintendent of motive power, C. & N. W., who said that the hump-yard operation would not necessarily be slowed up, since two cars are seldom switched one immediately after the other down the same track.

Mr. Nystrom suggested that a study be made to determine the impact strength of cast steel at sub-zero temperatures as a possible cause of coupler failures and Chairman Kleine said, in closing, that this and other questions developed in the discussion will be given further consideration by the committee.

The report was accepted and referred to letter ballot.

Report on Tank Cars

During the past year the committee considered a total of 413 dockets and applications for approval of designs as follows:

Two hundred and forty-seven covered designs, materials and construction of 3,829 new shipping containers, for application to new cars or for replacement on existing cars, in the number and of the classes listed in the table.

New Shipping Containers Considered by the Committee

Class	No. of tanks
I. C. C.-103	628
I. C. C.-103-W (Fusion welded seams)	276
I. C. C.-103-A	259
I. C. C.-103-A-W (Fusion welded seams)	2
I. C. C.-103-B	37
I. C. C.-103-B-W (Fusion welded seams)	20
I. C. C.-103-C-AL (Aluminum tank)	1
I. C. C.-103-C-W (Fusion welded seams)	5
I. C. C.-104	1
I. C. C.-104-A	42
I. C. C.-105-A-300	76
I. C. C.-105-A-300-W (Fusion welded seams)	402
I. C. C.-105-A-400	1
I. C. C.-105-A-500	36
I. C. C.-106-A-500	1,871
A. A. R.-201-A-35-W (Fusion welded seams)	37
A. A. R.-203	87
A. A. R.-203-W (Fusion welded seams)	48
Totals	3,829

Three applications covered eleven multiple unit cars to be used for the transportation of fifteen Class I. C. C. 106-A-500 one-ton containers each.

One application covered two new underframes and trucks on which would be mounted existing tank car tanks.

One hundred and forty-one applications covered alterations in, additions to or conversions and reconditioning of 2,751 existing tank cars or shipping containers.

Alterations in Existing Tank Cars or Containers

Class	No. of cars or tanks
A. A. R.-II	8
A. A. R.-III	1,100
A. A. R.-IV	1
A. A. R.-V	9
I. C. C.-103	112
I. C. C.-103-A	6
I. C. C.-103-B	2
I. C. C.-105	1
I. C. C.-105-A-300	20
I. C. C.-106-A-500	1,476
A. A. R.-201-A-35-W	3
A. A. R.-203	3
A. A. R.-203-W	1
Multiple unit tank cars	9
Total	2,751

Hearings are now tentatively set for an early date on the proposed general revision of the Interstate Commerce Commission Specifications For Tanks To Be Mounted On Or To Form Part Of A Car, indicated by the Committee's report of May 29, 1939 to have been previously submitted to the I. C. C.

Specifications for Fusion Welded Tank Car Tanks

At public hearings before the Interstate Commerce Commission, during September, 1934, your committee recommended the adoption of specifications, then presented, which would permit the construction of tank car tanks fabricated by means of fusion welding. Your committee, at the same time, recommended the use of tank car tanks so constructed for the transportation of articles classed as dangerous.

Proposed Alterations, Additions, Conversions or Reconditioning Operations, Affecting the 2,751 Cars or Shipping Containers

Application of heater systems.
Application of lagging.
Application of rubber lining.
Center Sills, reinforcing of.
Capacity reduced.
Conversion from A.A.R.-III to A.A.R.-III Insulated.
Conversion from A.A.R.-III Insulated to A.A.R.-III.
Conversion from A.A.R.-IV to A.A.R.-III Insulated.
Conversion from A.A.R.-IV to A.A.R.-III.
Conversion from A.A.R.-IV-A to A.A.R.-IV.
Conversion from I.C.C.-103 to I.C.C.-103 Insulated.
Conversion from I.C.C.-103-A to I.C.C.-103-A Insulated.
Conversion from I.C.C.-103 to A.A.R.-203.
Conversion from I.C.C.-103 to A.A.R.-203 Insulated.
Conversion from I.C.C.-103-B to I.C.C.-103-B Insulated.
Conversion from I.C.C.-103-B to A.A.R.-203 Insulated.
Conversion from I.C.C.-104 to I.C.C.-103 Insulated.
Conversion from I.C.C.-103 to I.C.C.-103-A.
Conversion from I.C.C.-103-A to I.C.C.-103-B.
Dome fittings and unloading arrangements altered.
Bolster slabbing area increased.
Reconditioning one-ton shipping containers.
Underframe reconditioned, in connection with the application of new tanks.
Alter for sulphur dioxide service.
Transfer from metallic sodium to ammoniating solution service.
Conversion from Acid Sludge to petroleum products service.
Dome and fittings renewed (not in kind).
Add jacketed outlet.
Cutting of present dome head—application of new dome shell.
Bolster slabbing and tank band snubbers applied.
Removal of washout—addition of 4" positive outlet.
Alter from General Service to Sulphuric Acid Service.
Repairing crack in manway by fusion-welding.
Alter from fertilizer ammoniating solution to General service.
Application of tank reinforcing rings under dome.
Conversion from Metallic Sodium to propane service.

A general revision of the 1934 proposed fusion welded specifications has been formulated, to incorporate necessary modifications in line with changes in the art, and to harmonize the requirements for tank car tanks, as near as is practicable, to the requirements of other code authorities.

Every effort is being made by the committee to complete their review of these revised fusion welded specifications to permit of submission of same to the I. C. C. so as to receive consideration at hearings proposed to be held in the near future on general revision of the currently effective shipping container specifications covering riveted and forge welded tank car tanks.

Fusion Welded Tank Car Tanks

Since the public hearings before the I. C. C. at Washington, D. C., on September 5, 6 and 7, 1934, on the matter of fusion welded tank car tanks the commission has authorized the construction of a total of 1,074 tank car tanks, fabricated in conformity with the proposed specifications then submitted, and their use in experimental service trials transporting articles classed as dangerous by their Regulations.

To date certificates have been filed indicating that, of the cars so authorized to be equipped, 442 have been constructed and placed in service. Since last report no advices have been received of any of these cars having been involved in accidents.

Reports are regularly received covering conditions of all fusion welded tank car tanks authorized for experimental trials. In addition, these reports also supply service records. These reports indicate a satisfactory performance for the fusion welded tanks now in service after having traversed 10,113,311 miles, during 13,530 trips.

Twenty-One Applications Requesting Approval of Tank Car Appurtenance Designs, without Reference to Specific Cars

Applications	Tank-car appurtenances
1	Safety valves equipped with breaking pin device and having upper and lower diaphragm for single unit chlorine tank cars.
1	Spot welding of safety appliance bolt nuts in place of riveting.
1	Dome platform arrangement for Class I.C.C.-104 tank cars.
1	Johns-Manville "HP" Stonefelt Insulation.
1	Johns-Manville type "WS" Stonefelt Insulation.
1	Nozzle Construction for I.C.C.-105-A-W tank cars.
1	Design of hand rail arrangement for multiple-unit tank cars.
1	Valve for slip tube gaging device.
1	Design of anchor rivet cap construction for all classes of I.C.C. fusion welded tank car tanks except I.C.C.-105-A series used for chlorine.
1	Design of anchor rivet cap for all classes of fusion welded tank car tanks which are not stress relieved.
1	Tank car loading and unloading valve with safety check valve —for pressure below 40 lbs. sq. in. for Class A.A.R.-IV or I.C.C.-104 tank cars.
1	Proposed bushing design for worn pipe connections on angle valve body for Class I.C.C.-105-A series chlorine tank cars.
1	Cast steel housing for valves and fitting to be applied to A.A.R.-III, IV, or I.C.C.-103 and 104 tank cars.
1	Bushing design for worn pipe connection on angle valves for Class I.C.C.-105-A chlorine tank cars.
1	Installation of Nickel Lining fusion welded in place and exterior heater coils to one (1) Class I.C.C.-104 tank car.
1	Installation and use of battery to supply counter electric current to Caustic Soda Liquor shipped in nickel clad tank cars.
1	Proposed 6" positive steam jacketed clapper type outlet valve.
1	Dome arrangement for Class I.C.C.-103-A tank cars.
1	Lead discs having 1/16" breather holes.
1	A.A.R. 16" hinged and bolted type manway with protective housing for loading and discharge fittings.
1	Alteration in disc assembly for 1" angle valve for use on Class A.A.R.-V, I.C.C.-105, I.C.C.-105-A-300 and 105-A-500 tank cars.

With a view to clarifying present standard definitions for tank cars your committee recommends submission to letter ballot proposed definitions for Class T tank car type cars and supplementary table as outlined by Appendix A. (Not included in the present abstract of the committee report.)

Tank Car Safety Appliances

Appendix A of United States Safety Appliances Hand Book, covering safety appliances for tank cars, was last revised during 1920. Since that time there have been a number of changes necessitated by the demands of shippers and their customers. Since parties proposing the construction of tank cars are required to secure committee approval before placing same in service and as no requirements outlining details of the additional appliances required by these demands have been adopted and published for general use this has necessitated submission of such applications to the Committee on Safety Appliances. With a view of eliminating delays attendant upon such handling your committee is formulating a general revision of Appendix A, to be designated as Appendix B, outlining safety appliance requirements for tank cars constructed in the future. Proposed Appendix B after concurrence by all parties will be submitted to the voting members for adoption by letter ballot.

Appendix A—Definitions and Designating Letters for Tank Cars

Proposed Form—Class T Tank Car Type, "TM"—Tank car

for transporting oil, gasoline, or other liquids, including liquefied compressed gases, but not including acids. Consists of a riveted, fusion welded or forge welded tank mounted on car structure. Design of tank and appurtenances for these cars is dependent upon the lading to be transported. Tanks must be equipped with safety valves or safety vents. Unloading may be through bottom discharge or, if not so equipped, overhead.

"TA"—Tank car for acid service. Of same general design and construction as oil tanks except same must be equipped with safety vents and overhead unloading arrangement. Safety valves and bottom discharge is prohibited.

"TL"—Tank car of same general construction as "TA" car except that tank is lined with aluminum, nickel, rubber, tin, zinc, etc., (except glass) to resist corrosive action of lading or prevent its contamination.

"TG"—Tank car having one or more glasslined tanks for transporting mineral water, etc.

"TGB"—Tank car for transporting beverages, etc., having two cylindrical metal tanks (with or without lining), the loading and unloading devices for same being enclosed within, and protected by a cab located between the tanks.

"TMN"—A car of suitable design for transporting removable non-dangerous articles containers.

"TMU"—A car of suitable design, including cradles and anchorage, for use in transporting liquefied compressed gas ton-containers of Class I. C. C.-106-A series and cars of I. C. C.-107-A series for transporting compressed gases.

"TW"—A car equipped with one or more wooden tanks, or, one or more metal or wooden tubs. Such tank or tubs may be lined. Car is sometimes equipped with a roof.

Note 1—Where tanks, tubs or containers mounted on any of the preceding Tank Car Type Classes are insulated the letter "I" should be affixed to their applicable designating letters. For example, TAI, TGI, TGBI, etc.

The report was signed by G. S. Goodwin (chairman), mechanical engineer, C., R. I. & P.; F. A. Isaacson (vice-chairman), engineer car construction, A., T. & S. F.; A. G. Trumbull, chief mechanical engineer, C. & O.; B. M. Brown, assistant superintendent motive power, Sou Pac.; W. C. Lindner, chief car inspector, Penna.; A. E. Smith, vice-president, Union Tank Car Company; G. A. Young, head, School of Mechanical Engineering, Purdue University; F. Zeleny, engineer of tests, C., B. & Q.; W. C. Steffa, transportation manager, Sinclair Refining Company; R. T. Baldwin, secretary, The Chlorine Institute, Inc.; H. J. Gronemeyer, supervisor, car equipment, E. I. duPont de Nemours & Company, Inc.; and R. W. Thomas, manager, Philgas department, Phillips Petroleum Company.

The report was accepted without discussion.

Report of Committee on Loading Rules

The annual report of the committee for 1940 embodies several changes in the present rules, as well as a number of new rules recommended by the shippers, all of which are of such importance as to merit very careful consideration.

During the past year we have again received the splendid cooperation of the shippers, as well as the member lines. The recommendations presented by the shippers have been very helpful to the committee in formulating new rules and modifying the present rules, where modification was deemed necessary to produce an economical, substantial and safer load. It is very gratifying to this committee to receive this excellent cooperation and support for the further betterment of loading practices and we, with the Association, desire to extend our sincere appreciation.

Experimentations with several new methods of load securement are in process and the results of the tests so far are very gratifying.

Two meetings have been held with the shippers during the past year, one with the lumber interests (creosoted pole shippers) in the south and one with the steel industries, both of which brought about a better understanding of the problems that confront the carrier and shipper.

The following changes and new rules are presented for your approval and adoption to become effective in supplement to the rules to be issued subsequent to the Annual Meeting.

General Rules

Rule 10

Add new sentence to Section (c) to read: "Stakes may be placed either in or out of stake pockets on inside of gondola cars with sides 30 in. high or over, provided they rest on car floor and are securely wedged to car sides by lading."

Reason: To clarify the rule.

Add new sentence to Section (d) to read: "Boards, lengthwise of car, attached to stakes above top of car sides, must be nailed to inside of stakes."

Reason: To eliminate the possibility of boards becoming detached in transit.

Change Section (f) to read: "Such fastenings need not be used when top tier of H and I beams with flanges 6 in. wide or more are loaded flatwise, and lower edges of flanges extend at least 4 in. below top of car sides and confined inside the flanges of beams underneath."

Reason: Greater safety.

Rule 11

To read as follows: "Substitution for High Tension Wire and Bands.—Where high tension bands or high tension wires are specified in the detailed rules, they may be substituted for each other, if of equal load strength, provided all the other items used to secure the load are equal in number and strength."

Reason: To serve as guidance.

Rule 14

Add new rule to read: "Nails. (See Figure 1-B.)"

Reason: To indicate the sizes of nails for the guidance of the shippers.

Rule 15

Change first paragraph Section (c) to read: "The substitution of high tension bands or high tension wires for rods, bolts or bands with threaded ends is permitted only when specified. When used they must have a percentage elongation in 6 in. from 5 to 16 per cent, inclusive.

Reason: Bands now used are generally hot rolled.

Change third paragraph Section (c) to read: "High tension bands or wires, encircling pile must be machine tensioned, sealed or twist tied, respectively, on top of load, when possible."

Reason: To indicate that it refers to machine tensioning.

Change fourth paragraph Section (c) to read: "Twist tie the ends of each wire to provide 85 per cent load strength. Seal each band with one double crimp or two single crimp seals, 85 per cent load strength of band, except otherwise specified."

Reason: To clarify the intent.

Rule 16

Change Section (d) to read: "Authority must be procured for handling loads which measure more than 8 ft. from top of rail to center of load."

Reason: To provide that all loads exceeding this height must be handled as special loads.

Rule 18

Change Section (a) to read: "The width of load, distance between bearing-pieces, and length of overhang must not exceed the dimensions shown in tables No. 3 to 35, inclusive. For loads of uniform width throughout length of load, the minimum width *W* is to apply. Authority must be procured for handling loads which measure more than 8 ft. from top of rail to center of load."

Reason: The following wording has been eliminated account being fully covered by General Rule 7, "for loads 12 ft. high or less, measured from top of rail to top of load. For loads over 12 ft. high from top of rail to top of load, the given width must be reduced 2 in. for each inch in height for that portion of load in excess of 12 ft." Last sentence has been added to indicate that all loads exceeding this height must be handled as special loads.

[The remainder of the report was devoted to the details of revisions made either to the drawings or the text accompanying the drawings in Figs. 3, 5, 6, 22, 27, 27-A, 29, 30, 31, 51, 51-A, 63, 63-A, 66, 69, 134, 135, 198 and 199-A. New figures 71-A, 84-B and 200-A were added, covering the loading of wire mesh in rolls, transite pipe and granite.—Editor]

The report was signed by W. B. Moir (chairman), chief car

inspector, Pennsylvania; C. J. Nelson (vice-chairman), superintendent interchange, Chicago Car Interchange Bureau; R. H. Dyer, general car inspector, N. & W.; H. S. Keppelman, superintendent car department, Reading; T. W. Carr, superintendent rolling stock, P. & L. E.; A. H. Keys, district master car builder, B. & O.; H. H. Golden, supervisor A. A. R. Interchange and Accounting, L. & N.; H. T. DeVore, chief interchange inspector, Youngstown Car Inspection Association; H. J. Oliver, general car inspector, D. T. & I.; and F. G. Moody, master car builder, Nor. Pac.

Discussion

In presenting this report, Chairman Moir said that a study of disarranged loads during the period between January 1 and May 1, 1940, indicated that 3,465 cars were shopped for readjustment of the load, 1,898 being due to yard switching and 1,367 to road haul, the estimated cost of labor and material for this work, estimated on an annual basis, being $37,825. This cost must be reduced by an organized campaign carried out with the same thoroughness as the safety program. Only about 50 per cent of the cases of load shifting are reported by the railroads, according to Chairman Moir, who expressed appreciation for the excellent cooperation secured from many shippers, especially in the handling of experimental test loads. J. McMullen, superintendent car department, Erie, said that this report is always important and must represent the result of intelligent research and complete cooperation between railroads and shippers if desired results are to be obtained. He called attention to the use of high-tensile steel bands and wires as an important factor in modern loading; urged the closer observance of loading rules; stressed the importance of reporting all failures; urged closer supervision of loading practices by the transportation department, and said that the membership should cooperate more fully with the Loading Rules Committee, as all apparently do not realize the amount and importance of the work which it does in the interest of the railroads as a whole.

The committee report was adopted.

Intercrystalline Cracks in Locomotive Boilers[1]

By W. C. Schroeder[2]
A. A. Berk[3]
R. A. O'Brien[4]

Approximately 500 locomotive boilers are known to have suffered embrittlement or intercrystalline cracking during service on American railroads. The actual number may be considerably greater as statistics on this type of failure are extremely difficult to make complete. The major portion of this cracking had been confined to four or five railroads but it has recently cropped up on a number of roads heretofore free from this trouble.

The use of welded drums in stationary practice probably presages steady diminution of intercrystalline cracking in this field, for such construction eliminates the riveted areas which experience has shown to be most prone to this type of failure. In locomotive boilers no general tendency toward the use of welded drums is yet in evidence, consequently alleviating the trouble depends on proper attention to (1) the construction of the boiler, (2) the treatment of the feedwater, or (3) combination of the best construction with adequate feedwater treatment.

The Association of American Railroads, recognizing this situation, has contributed generously to an extensive investigation of this problem. From the standpoint of protecting riveted stationary boilers already in service, the work has also been sponsored since its inception by the American Boiler Manufacturers Association, American Society of Mechanical Engineers, American Society for Testing Materials, American Water Works Association, Edison Electric Institute, and other interested groups.

This investigation has been carried out in cooperation with the Bureau of Mines,[5] which has furnished not only excellent facilities but also the services of experimental investigators.

Considerable attention has been devoted to understanding how the cracks occur as a guide toward finding and evaluating methods of feedwater treatment that may be used to prevent them.

Three factors combine to produce intercrystalline cracks in a boiler: (1) leakage that allows concentration of the boiler water, (2) high stress in the boiler metal, arising either from cold work or applied stress, and (3) chemical action of the concentrated boiler water on the stressed steel.

Concentration of the Boiler Water

It has never been possible to show that a dilute alkaline solution, such as ordinarily present in a locomotive, will produce intercrystalline cracks when in direct contact with stressed specimens of normal low carbon steel at any temperature used in boiler operation. It is not necessary to show this, however, to account for the appearance of intercrystalline cracks in a riveted boiler seam. Instead of the dilute water acting on the steel, a *concentrated* solution produced in the seam is the attacking agent.

Several mechanisms have been advanced to explain this concentration process. That most easily demonstrated depends on the extremely slow diffusion of water vapor out of the seam to leave therein a deposit of concentrated solution and solid.

Fig. 1 shows on a greatly magnified scale a small leak between the drum metal and butt strap of a boiler. Point *A* represents an opening so small that the boiler water can diffuse through it only very slowly. As this occurs, the heat in the metal and in the liquid will cause evaporation toward atmospheric pressure to produce a more concentrated solution. Still farther away from the opening more evaporation has occurred and the boiler water is quite concentrated. Next, solids such as sodium sulfate and chloride begin to crystallize from solution, and finally substantially all the water is evaporated.

From Fig. 1 it is apparent that the rate of leakage must be confined within certain limits to produce a concentrated solution. If no leakage occurs, concentration is not possible. On the other hand, if opening *A* is too large, the water will rush out so rapidly that concentration may not occur in contact with the stressed metal. The most dangerous type of leakage is that which allows an almost imperceptible loss of water vapor to the atmosphere.

Leakage as represented by Fig. 1 probably would never be directly visible on an engine and certainly never enough to cause

[1] Published by permission of the Director of the Bureau of Mines—U. S. Department of the Interior.
[2] Senior chemical engineer, Eastern Experiment Station, Bureau of Mines, College Park, Md.
[3] Assistant chemist, Eastern Experiment Station, Bureau of Mines, College Park, Md.
[4] Assistant metallurgist Joint Research Committee on Boiler Feedwater Studies, attached to the Eastern Experiment Station, Bureau of Mines, College Park, Md.

[5] Abstracts of earlier investigations by the Bureau were published in the September, 1938, and June, 1940, issues of the *Railway Mechanical Engineer*.

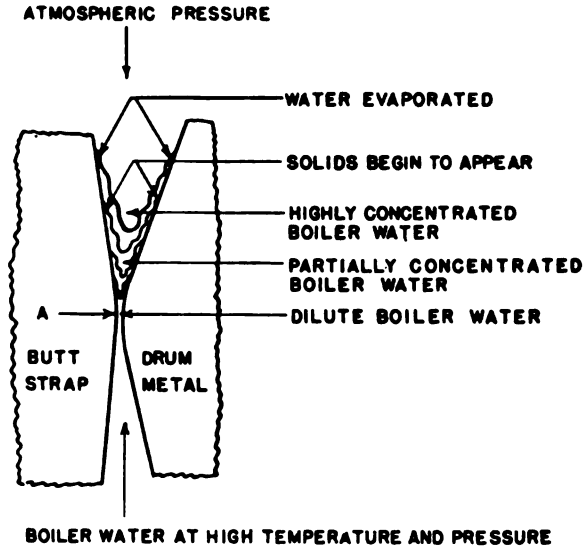


Fig. 1—Greatly magnified diagram of a leak showing concentration mechanism

removal from service. It could be discovered in a cold test only with most careful inspection. When the boiler is under full steam pressure, however, such leakage might be found with a cold glass or mirror on which steam escaping from a riveted seam will form a faint haze of condensate. Over long periods of time rates of leakage undetectable even by this rather sensitive means can create concentrated solutions.

High Stress in the Boiler Metal

It has been known for a long time that intercrystalline cracks occur most readily when the metal is under a high tensile stress. In fact no definite evidence has been advanced to show that they can be produced in unstressed steel or in steel subjected to compression.

This usually has been interpreted to mean applied stress; therefore in laboratory work to produce intercrystalline cracks the specimens were put under tensile load by dead weight, springs, lever or hydraulic systems. It can be shown that an applied tensile force is not always necessary to produce cracks. If the inner surface of a rivet hole has been cold-worked through punching, drilling, drifting, or other mechanical operation the necessary internal stress may exist to cause cracking in the absence of any further applied load.

The desirability of preventing extensive cold distortion of the metal during fabrication of the boiler is apparent from this work. Excessive distortion of the metal would create all the stress necessary to cause embrittlement, and at the same time would make it almost impossible to keep the boiler free from leaks that would allow the formation of concentrated solution in the seam.

For a number of years manufacturers have recognized the necessity for eliminating this type of construction. Plates are carefully fitted together, all burrs and chips are removed from between them, all rivet holes are drilled rather than punched, and the holes are reamed in place to secure proper alignment. Rivets are driven by machine so that the heads are well centered over the shanks.

Internal calking has been used quite generally in recent years, in locomotive construction. Operating experience has not as yet clearly demonstrated the superiority of internal-external calking over external calking alone.

To secure a tight fit between locomotive shell courses they are sometimes shrunk together. The advisability of this procedure is debatable. The shrinking probably secures a better fit between the shell courses, which will greatly aid in preventing leakage, but it may set up extremely high tensile stresses that will promote rapid cracking in case any concentrated solution does form. According to the writers' information one of the railroads which has had considerable difficulty with circumferential seam cracking did not follow the practice of shrinking courses together and it may be concluded that elimination of the stresses from this source is not a sure way to prevent embrittlement.

Action of Concentrated Solutions on Stressed Steel

In the riveted seam of a locomotive boiler we have seen that two of the conditions can exist which are necessary to cause intercrystalline cracking; namely, leakage that will allow the formation of a concentrated solution, and high stress in the metal. To actually crack the steel still another factor must be acting; a boiler water which on concentrating will have the correct chemical characteristics to attack the grain boundaries of the metal.

This chemical problem is extremely complex, and as it has been treated in some detail in previous publications only the most practical aspects concerning caustic solutions need be repeated here.

A stressed steel specimen placed in direct contact with a very concentrated sodium hydroxide solution, boiling under atmospheric pressure, will suffer intercrystalline cracking. This attack can be hastened greatly by adding very small amounts of certain chemicals, generally classified as oxidizing agents, to the solution. When the solution is raised from the atmospheric boiling point to temperatures used in locomotive operation, the oxidizing agents lose their effectiveness in accelerating the cracking. A trace of certain types of silica sometimes will promote attack and the influence of this compound becomes even more important at still higher temperatures (corresponding to 500 lb. per sq. in. pressure and above). The action of the silica is complex and its influence will be treated in further detail later in this paper.

Several theories have been advanced to explain intercrystalline cracking in boiler steel. The one that best correlates available information is based upon a process of selective corrosion.

The Embrittlement Detector

A set of conditions that produce intercrystalline cracking in locomotive boilers has been outlined. If these ideas are correct, a testing device can be used to show whether or not a locomotive boiler water can cause this type of failure. Furthermore, the equipment can be attached directly to the boiler so that a portion of the water continuously pours into or through it, avoiding sampling with its attendant difficulties and errors. The "embrittlement detector", has been successfully developed for this purpose.

Fig. 2 shows the essential details of the embrittlement detector. The base of the detector is a rectangular block 5 in. long, 2¼ in. thick, and 3¼ in. wide, with a ¾-in. hole through which the

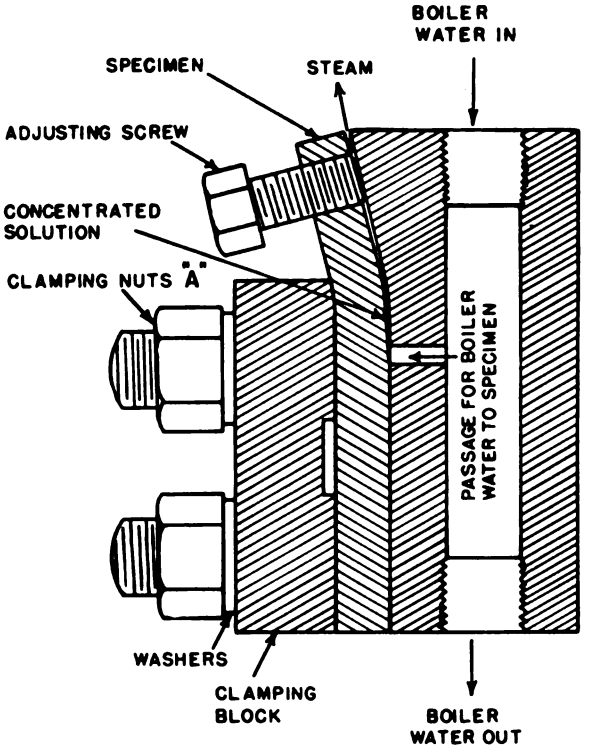


Fig. 2—Cross-section of the embrittlement detector

boiler water circulates. A machined groove receives the specimen. The latter is a steel bar 5 in. long, ¾ in. wide and ½ in. thick. (In the laboratory some specimens also have been used which are 5 in. long, 1¼ in. wide and ⅝ in. thick); bent and held in place by the nuts and clamping block. The unit is heated to operating temperature by the circulation of boiler water. A small hole conducts the water to the contact surfaces between the specimen and base block and by the correct setting of the clamping nuts and adjusting screw a very slow diffusion of steam is established out the end of the specimen. This diffusion is best detected by holding a cold glass or mirror over the end of the unit, and the most desirable adjustment will show only a slight haze of condensed steam. The concentrated solution forms under the bent area of the specimen and laboratory as well as plant tests show that cracking will result if the boiler water is embrittling.

Prevention of Intercrystalline Cracks

From the three factors known to be involved in the production of intercrystalline cracks it is evident that for new locomotive boilers two entirely different approaches might be employed for their elimination; i.e., to build the boilers in such a manner that they are not susceptible to cracking or to treat the water so that it will not cause cracking in any boiler.

In many ways the former of these has all the advantage, for the operator could then forget about embrittlement through the

life of the locomotive. On the other hand, if he relies on feedwater treatment, he must constantly and continuously have reports on chemical conditions. This is difficult for a railroad with hundreds of engines in service over a wide geographical area and raw water conditions subject to the vagaries of season and weather.

However, there are thousands of old locomotives in service and it is not yet certain that new boilers, because of construction limitations, are immune. Therefore, in spite of the difficulties, feedwater treatment frequently must be relied upon to prevent embrittlement. Sodium sulfate has sometimes been recommended for this purpose but it will be shown that its influence on locomotive boiler cracking is extremely doubtful. In many instances the data indicate that organic materials will give better results.

Construction of Boilers Resistant to Embrittlement

Embrittlement, in the very great majority of cases, has been found in the riveted seams of boilers. A direct remedy for the trouble would be to eliminate such seams, a practice now commonly followed in stationary boilers through the use of welded or forged drums. While welding has not yet been generally allowed for locomotive boilers, one test engine so constructed is reported to have operated successfully several years and may foretell very definite advances in this direction. Permitted use and adoption of welded seam construction is a direct and, judging from stationary experience, foolproof method that prevents this type of cracking.

A steel resistant to embrittlement would offer another solution. A number of years ago, Fry* reported that Izett steel had qualities superior in this respect to ordinary boiler flange steel. During the spring of 1939 the authors discussed this material with two engineers from the Fried. Krupp Company. It was their belief that in recent years it had been improved and now had greater resistance to embrittlement cracking. These engineers forwarded a small sample, designated as Izett II, for testing.

In three of four tests made of this steel in the embrittlement detector, no cracking was found. The other test showed some surface checking and three or four fine, extremely short cracks which, even after severe bending of the specimen at the end of the test, were only a few thousandths of an inch deep. Investigation for longer periods which is now being conducted, may crack this steel but it appears definitely superior to any American boiler plate that has been tested in the embrittlement detector. The results would indicate that study to develop for use in locomotives a steel that is resistant to embrittlement is not without promise.

A series of tests, comparable with those on the Izett steel, is now being conducted on a steel of American manufacture which was treated with aluminum and may be thoroughly deoxidized.

In locomotive construction low-alloy steels have been in common use in the past few years, generally with the express purpose of saving weight in order that the safe load on tracks and bridges may not be exceeded. These steels may have different characteristics in embrittlement tests from low-carbon boiler flange steel. The locomotive manufacturers, aware of this fact, have started cooperative work that may help to guide them in the selection of steel for new boilers.

Regardless of the steel used for construction, too much stress cannot be placed on careful design and shop practices. The experience of German engineers with stationary boilers aptly illustrates what may be accomplished by careful construction. From the time of the war until 1925 or 1926, embrittlement was as prevalent and annoying in Germany as it was in this country. The German engineers, in contrast to those in the United States, did not believe that water conditions were the only important factor, but instead that cracking was caused by poor boiler construction resulting from the haste and pressure of war conditions. With this idea in mind they improved their shop technique as much as possible and reported results indicate that this approach has been successful, greatly reducing and almost eliminating cracking in stationary boilers.

Some very interesting data have been accumulated from one railroad in the United States illustrating the unexpected manner in which serious embrittlement trouble may arise, and the difficulty of isolating the cause from the complex factors of design, workmanship, and chemical condition of the water that are known to be involved. A comparison of the number of engines in a given class that were embrittled, with the year in which they were built including only classes with 10 or more engines shows that of 602 engines built between 1902 and 1921 only 6, or one per cent, were cracked at the end of 1937. Individual classes are also interesting. For example class 1 with 211 engines suffered embrittlement in one, and class 5 with 150 engines did not have any cracked. The maximum percentage cracking is 20 for class 7.

Of 335 engines built between 1924 and 1930, not one per cent, but 120 engines or 36 per cent were cracked by 1937. In class 13, 34 boilers from a total of 45, or 76 per cent, were embrittled. Fifty-four per cent of the boilers in class 11 were cracked.

It seems reasonable to believe that there was some definite change, probably in engine construction or feedwater treatment, that caused the marked increase in cracking after 1921. The design and construction have been examined as closely as possible to determine what this might be. Changes were made from triple- to double-riveted circumferential seams and the efficiency of the longitudinal seams was also increased from 80 per cent to approximately 90 per cent, which resulted in the thickness of the boiler sheets being decreased. Riveting methods and pressures probably have gone through several changes over this long period; from hand to high pressure machine riveting and then back again to machine with care exercised to prevent excessive distortion of the plate. This may be a significant factor although this road has not yet discovered a riveting pressure that will prevent embrittlement. The steel used for the shell courses might also have altered over a period of years to be more susceptible to cracking. This argument is not too strong, however, for another railroad experienced its greatest difficulty between 1912 and 1926, indicating that some of the steel plate during this period was susceptible to cracking.

Up to 1926 only a small portion of the feedwater was treated to prevent scale and corrosion. At that time general conditioning was started on the road, using external treatment on some supplies and internal on others. This essentially eliminated scale formation as well as pitting and corrosion and also probably caused an increase in sodium hydroxide concentration in most of the boilers. It might be concluded that this was the important factor in causing embrittlement but *careful note should be taken of the fact that 335 locomotives, built prior to 1921, were still in operation in 1937 using the same water supply as the new locomotives and these do not have appreciable cracking difficulties.*

This clearly focuses the question as to why these older boilers can use an embrittling water without much difficulty. So far, as noted, differentiation between new and old boilers on the basis of construction factors alone has not been possible. Perhaps the use of the older engines, while the water formed scale, and was corrosive, created conditions in the seams that were unfavorable to embrittlement. Specifically, these might consist of deposits of calcium silicate or sulphate that prevented leakage. It is, however, difficult for the writers to believe that protection based on mechanical plugging to prevent leakage could exist over a period of years in a locomotive boiler.

While mechanical plugging of the seam is of doubtful significance, a thin film, chemically bonded to the steel surface, may have greater protective value. Detector specimens exposed to certain types of boiler water have been found covered with very thin and extremely adherent calcium or iron silicates. Even if leakage did occur such a film could separate the concentrated solution from the metal surface to prevent cracking. If this explanation is correct experimental demonstration may be possible.

Before treatment was in general use on this road, the locomotive boiler waters were quite corrosive, and caused a great deal of pitting and rusting. In the seams this may have formed an oxide coating through which it would be difficult to start cracking even in contact with the concentrated alkaline solution. Experimental testing of this possibility has been begun.

Clear cognizance should be accorded the fact that not all the engines manufactured since 1924 have cracked, in spite of the fact that they normally seem to operate with highly embrittling waters. In other words, the engines built prior to 1921 may be protected by scale or corrosion, but some engines built after 1924

* The Behavior of Materials Used in Boiler Construction When Subjected to Service Conditions. Ing. Fry. Kruppsche Monatshifte, V. 7, pp. 185-196 (November, 1926).

also can use embrittling waters without cracking. This may indicate differences of construction with important bearing on embrittlement, hidden even in engines of identical design. Not understanding these differences it remains for the locomotive boiler manufacturer to keep cold work stress at a minimum and yet to keep the boiler as free from leaks as possible.

Conclusions

Two of the three factors are independent of water conditions. Therefore, if sodium sulfate or any other compound is maintained in a boiler water and cracking does not occur it cannot be concluded that the water contained a protective agent. The boiler may have been so constructed that it would not have cracked in the absence of such treatment. This complex situation makes difficult the interpretation of statistical results and probably explains the widely different opinions regarding the action of sodium sulfate held by some engineers responsible for stationary boilers as compared to the opinions held in railroad practice.

Results from three different types of laboratory testing equipment have not shown that sodium sulfate will stop cracking of the specimens. This is true even under conditions that appear to represent closely those existing in a riveted seam. Data reported by the railroads would tend to support these results.

Waste sulfite liquor has been found to stop cracking of hot-rolled boiler-flange steel specimens in the detector tests. Sodium sulfate and sodium chloride were found to interfere with the protection shown by waste sulfite liquor. In spite of this limitation it may have played an important part in stopping one very prolonged case of embrittlement on one railroad. A second road, that has used this material for about two years, reports a sharp decrease in engines found leaking from cracks in road service. The use of waste sulfite liquor is not recommended without chemical control of the concentration in the boiler water or without use of the embrittlement detector to insure adequate treatment.

Any feedwater treatment used to prevent embrittlement cracking must be under continuous control. On the other hand, if a boiler is constructed which is resistant to embrittlement the danger is removed throughout its life. Welding the seams would be one means of accomplishing this purpose but at the present time such construction is not generally permitted in locomotive boilers. Another possibility would be the use of a steel resistant to intercrystalline cracks. Tests in the embrittlement detector show that Izett steel may be better in this respect than ordinary boiler flange steel.

Even with present methods a great deal can be done to prevent trouble when the locomotive boiler is being built. The importance of careful design, construction and shop practice cannot be overemphasized. Every care should be exercised to make the seam tight and to prevent excessive cold distortion of the metal.

Even though water treating methods to prevent embrittlement are complex and suffer definite limitations, the evidence from railroad operation indicates that their combination with good construction can reduce costly and dangerous embrittlement cracking.

Discussion

F. E. Russell, mechanical engineer, Southern Pacific, expressed his interest in the hypothesis set forth by the author to account for the intercrystalline weakening of a boiler material under conditions of high caustic concentration and stress. He considered the embrittlement detector developed in the investigation conducted under the joint support of the A. A. R. and other organizations for the solution of the embrittlement problem a valuable contribution. The hypothesis which requires a combination of slow leakage and stressed metal as well as caustic concentration is fortunate since it would be very expensive to eliminate the chemical factor alone. With the character of shop practice shown in some of the slides by the author, he said, it would not be surprising to have trouble of the kind indicated. Boiler sheets, he said, should be handled with care to protect the surface. This will go a long way to prevent all kinds of chemical attacks.

In fabrication there should be no drifting of rivet holes, reaming alone being employed. All lubricants and cuttings should be removed before riveting. No sharp-edged calking tools should be employed and inside calking should be light because the rivets are usually too far apart to support heavy calking. Riveting, he said, should preferably be hydraulic. With proper shop practice he expressed the opinion that the riveted locomotive boiler would approach the welded stationary boiler in freedom from chemical attack. On the Southern Pacific, he said, there have been no cases of embrittlement. This road uses the Zeolite treatment.

H. G. Miller, engineer tests, C. M. St. P. & P., was inclined to disagree with Mr. Russell that riveted construction can approach welded construction in freedom from the embrittlement difficulty. As long as joints are riveted the metal will be locally and unsymmetrically stressed.

The report was accepted with a rising vote of thanks.

Report of Arbitration Committee

During the year Cases 1772 to 1778, inclusive, have been decided and copies forwarded to the members. A copy of these decisions is made part of this report. A vote of concurrence in the decisions is respectfully requested by the committee.

It is the intent that repairs to foreign cars should be confined to the minimum, in order that car owner may have opportunity to perform as much of the maintenance work on his own equipment as possible. Revisions of Rules 1 and 16 are recommended which should clarify this feature.

The requirement in Paragraph (b-10) of Rule 3 which provides that brake shoes meeting requirements of A. A. R. Specification adopted in 1935 are required on all cars when received from owners, has been in the rules since January 1, 1936. No requests for extension of effective date beyond January 1, 1941, have been received. The committee feels sufficient time has elapsed to permit compliance and that no further extension of effective date is justified.

Attention is directed to modification of Paragraph (4) of Section (t) of Rule 3 issued in Supplement No. 1 in March, 1940, as result of letter ballot action, making the prohibition against acceptance of cars having arch bar trucks a general interchange requirement effective July 1, 1940.

A new paragraph is recommended under Rule 17 to provide a tolerance in width for application of running boards, which it is felt should be permitted due to variations in commercial widths as purchased from the manufacturer and shrinkage while in stock.

With the concurrence of the Committee on Couplers and Draft Gears, an addition to Rule 20 is recommended to provide for alignment of drooping couplers by the application of coupler shims in cases where coupler is not below prescribed minimum height from top of rail.

A revision of Rule 44 is recommended which provides a more explicit definition of the defects enumerated under this rule and which it is felt will facilitate inspection of cars in interchange.

Recommendation was submitted in the 1939 report and approved, to provide separate depreciation for tanks renewed on existing underframes and trucks for use in settlement for destroyed tank cars. Investigation discloses a number of existing tanks have been mounted on new underframes and new trucks. Therefore, a further modification of the rule is recommended to extend the same principle to this reverse operation.

Studies are being conducted on a number of representative railroads of the overhead allowances now used in formulating the A. A. R. labor rate. If it develops modification is necessary as result of this study, with the approval of the General Committee the revision will be included in the 1941 Code.

The committee does not feel that any of the modifications included in its report necessitate submission to letter ballot.

All recommendations for changes in the Rules of Interchange submitted by members, railroad clubs, private car owners, etc., have been carefully considered by the committee and, where approved, changes have been recommended.

Attention is again directed to the fact that the Arbitration Committee will not consider questions under the Rules of Interchange unless submitted in the form of Arbitration Cases as per Rule 123.

Freight Car Rules

Rule 1

The committee recommends that this rule be modified, effective August 1, 1940, as follows:

Proposed Form: Rule 1. (a) Each railroad is responsible for the condition of all cars on its line, and must give to all equal care as to inspection *and lubrication.*

(b) Repairs should be made by car owner insofar as may be practicable. In the event a foreign car requires repairs account of owner's defects, *such repairs may be made subject to the following conditions:*

1. Repairs to loaded cars must be confined to the minimum necessary for the safety of cars, lading and trainmen.

2. Repairs to empty cars located at points where there is a direct connection with car owner, or where there is an intermediate switching line to car owner and cars are acceptable to such switching line for movement to car owner, must be confined to the minimum necessary for safety of trainmen and safe movement of car to home line.

3. Repairs to empty cars at other points must be confined to the minimum necessary for safety of car and trainmen, except where car is to be loaded on repairing line, in which event paragraph (b-1) applies.

4. Empty cars of lower loading classification may not be repaired for Class A loading without car owner's consent.

5. Cars requiring repairs so extensive as to be reportable under Rule 120, *shall* be handled in accordance with that rule.

Reason: To clarify the intent that repairs to foreign cars should be confined to the minimum and to give car owner an opportunity to maintain his own equipment.

Rule 2

The committee recommends that first paragraph of Section (b) of this rule be modified as follows:

Proposed Form: (b) Cars loaded with explosives *and other dangerous articles* must be handled in accordance with the *I. C. C.* Regulations.

Reason: The same penalties are provided for violation of these Regulations with respect to "other dangerous articles" enumerated therein, as for violations involving explosives.

The committee recommends that Paragraph 2 of Section (f) of this rule be modified, effective August 1, 1940, as follows:

Proposed Form: 2. All truck defects on foreign cars; except defective metal bolsters or center plates cast integral therewith, defective truck sides and metal transoms, defective non-A. A. R. standard journal boxes where the A. A. R. Standard is not a proper substitute. *However, where a loaded car is equipped with type of trucks prohibited under Rule 3, transfer authority is proper.*

Reason: To relieve receiving line from expense of transfer on cars which are prohibited in interchange under Rule 3.

Rule 3

The committee recommends that effective dates for various requirements in the present rule, as listed below, now set at January 1, 1941, be extended to January 1, 1942:

Section (b), Paragraph (8)—Bottom rod and brake beam safety supports.

Section (b), Paragraph (9)—Braking power.

Section (c), Paragraph (11)—Couplers having 5 by 5 inch shanks.

Section (j), Paragraph (2)—Journal boxes, repacking of.

Section (t), Paragraph (3)—Application of welded side frames having "T" or "L" section compression or tension members.

Section (u), Paragraph (4)—Class E-3 cars not to be accepted from owner.

Reason: The present situation justifies these extensions.

The committee recommends that no further extension beyond January 1, 1941, be granted for effective date of requirement contained in Paragraph (10) of Section (b) of this rule, specifying that cars must be equipped with A. A. R. 1935 Specification brake shoes to be acceptable from owner.

Reason: This requirement has been in the rules for several years and it is felt sufficient time has elapsed to permit compliance therewith.

The committee recommends that Paragraph (3) of Section (s) of this rule be modified, effective August 1, 1940, as follows:

Proposed Form: (s-3) Stenciling: Date built new, month and year, or badge plate giving this information, required on all cars. Date rebuilt, in addition to date built new, month and year, or badge plate giving this information, required on all cars rebuilt on or after July 1, 1928. From owners. In event tank and underframe of tank cars are built at different times each must bear distinctive dates, the date on underframe to be date *underframe (including trucks) was built new.*

Reason: To harmonize with change in Paragraph A-5 of Rule 112.

Rule 4

The committee recommends that a new second sentence be added to Paragraph (a) of this rule, effective August 1, 1940, to read as follows:

(a) In the case of damage to a car for which the delivering line is responsible, such line must, at the first available inspection point, attach defect card to cover. *Car owner should repair such defect-carded defects and remove defect car the first time car is shopped to car owner's repair track or repair shop.* On cars extensively damaged, etc. (no other change).

Reason: Defect card damage should be repaired promptly.

The committee recommends that second paragraph of Section (b) and third paragraph of Section (f) of this rule be modified, effective August 10, 1940, as follows:

Proposed Form: (b-2) If cars are offered in interchange with damage other than referred to in Paragraph (b-1), on which there is conclusive evidence of unfair usage, the receiving line shall require that defect card be attached to car, per Rules 2 and 14. Damage to or beyond extent specified in Sections (c) to (h), inclusive, *except when due to corrosion,* will be classified as unfair usage for which defect card shall be issued in interchange.

(f-3) Metal side and end sheets: Holes through the thickness of the metal to an extent exceeding three inches measured in any direction, except when due to shifting of loads from within the car.

Reason: To clarify the intent. Damage due to corrosion should be owner's responsibility.

The committee recommends that Paragraph (2) of Section (c) of this rule be modified, effective August 1, 1940, to read as follows:

(c-2) Metal posts, metal braces and metal sheets: Bent inwardly 1½ inches or more. Bulb portion only of pressed steel parts, or flanges only of structural *or pressed steel* shapes, when bent, regardless of extent, will not be cardable except where necessary to repair under conditions referred to in Paragraph (3).

Reason: Flanges of pressed steel parts are entitled to same protection as flanges of structural shapes.

The committee recommends that a new last sentence be added to first note following Section (d) of this rule, effective August 1, 1940, to read as follows:

Note.—It is understood that adjoining raked sheathing if not split or broken will not be cardable unless raked into tongue, except that on refrigerator cars sheathing boards raked to bottom of bead but not into tongue will also be cardable if they adjoin (in consecutive order) the board raked into tongue, broken or split. Sheathing damaged due to use of bar for closing side door is not cardable. *Damaged or missing short sheathing boards under doorway are not cardable.*

Reason: These defects are not considered detrimental and frequently do not result from unfair usage.

The committee recommends that Paragraph (1) of Section (f) of this rule be modified, effective August 1, 1940, to read as follows:

(f-1) Metal posts, metal stakes, metal braces, metal top chord angles, or their substitutes: Bent inwardly four inches or more. Bulb portion only of pressed steel parts, or flanges only of structural *or pressed steel* shapes, when bent, regardless of extent, will not be cardable except where necessary to repair under conditions referred to in Paragraph (2).

Reason: Flanges of pressed steel parts are entitled to same protection as flanges of structural shapes.

The committee recommends that a new second note be added to Paragraph (6) of Section (f) of this rule and issued in the next supplement, to read as follows:

Note.—Bent metal side and end sheets are cardable only when bent in connection with cardable bent posts, stakes, braces, metal top chord angles, or their substitutes.

Reason: To clarify the intent.

The committee recommends that first and second paragraphs of Section (k) of this rule be modified as follows:

Proposed Form: (k) (1) When a car is received home with unfair usage defects covered by defect card bearing notation "Home for Repairs," and it develops that there are associated defects due to unfair usage which evidently occurred at same time, joint inspection *as outlined in Rule 12,* may be made within

90 days after first receipt of car home, and joint inspection certificate issued showing list of defects covered by the defect card as well as list of additional associated unfair usage defects. Such joint inspection certificate shall be forwarded to the road issuing defect card which shall issue additional defect card to cover.

(2) When a car is received home covered by defect card not bearing notation "Home for Repairs," and it develops there are associated, concealed defects due to unfair usage (except interior fire damage per Rule 32, Section k), which evidently occurred at same time, joint inspection *as outlined in Rule 12,* may be made within 90 days after first receipt of car home, and joint inspection certificate issued showing list of defects covered by the defect card as well as list of the additional associated concealed unfair usage defects. Such joint inspection certificate shall be forwarded to the road issuing defect card which shall issue additional defect card to cover.

Reason: To harmonize with the provisions of Rule 12.

Rule 9

The committee recommends that a new requirement be added to this rule, effective August 1, 1940, with respect to information which must appear on billing repair cards, opposite heading "General," to read *"Empty or loaded car."*

Also, that the billing repair card forms (pages 267 and 268) be revised to include space for showing this information in upper right-hand corner.

Reason: This information is necessary in connection with revision of Rule 1.

Rule 16

The committee recommends that first paragraph of this rule be modified, effective August 1, 1940, as follows:

Proposed Form: Rule 16. Any car having defects which render it unsafe, may be repaired, subject to provisions of Rule 1.

Reason: To harmonize with revised Rule 1.

Rule 17

The committee recommends that a new Note 7 be added to the brake beam substitution table under Section (e) of this rule, to read as follows:

Note 7.—Insofar as substitutions, charges and credits are concerned, the No. 4 brake beam shall take the status of the No. 3 beam.

Reason: It is considered the No. 3 beam is ample in strength and can consistently be classified as a proper substitute for the No. 4 beam.

The committee recommends that present Section (k) of this rule be relocated as new Section (l); also, that a new section to be designated as Section (k) be added, to read as follows:

Proposed Form: (k) *In the application of running boards, a difference in width of ¼ in. (plus or minus) from that standard to car, will be considered as proper repairs, providing the boards applied do not violate safety appliance requirements.*

Reason: Due to shrinkage and account of variations in commercial widths as purchased from the manufacturer, it is felt this tolerance should be permitted.

Rule 19

The committee recommends the effective date for tenth item under this rule, now set at January 1, 1941, be extended for one year, to read as follows:

Welded cast-steel truck side frames having "T" or "L" section compression or tension members, on and after January 1, *1942.*

Reason: To harmonize with extension recommended under Rule 3.

Rule 20

The committee recommends that Paragraph (f) of this rule be modified, effective August 1, 1940, as follows:

Proposed Form: (f) *When coupler within prescribed height limits is found to be drooping (one inch or more with key attachment, or ¾ inch or more with riveted attachment), same should be corrected as provided in Paragraph (b). Coupler droop is the distance which center face of line of coupler butt.* When couplers or draft gears are removed, replaced or renewed for or on account of repairs, and coupler height is within prescribed limits, the couplers and draft gears should be properly aligned as provided in Paragraph (b).

Reason: To provide for alignment of drooping couplers when coupler is not below prescribed minimum height from top of rail. This recommendation has the concurrence of the Committee on Couplers and Draft Gears.

Rule 22

The committee recommends that a new first paragraph be added to this rule, to read as follows:

Rule *22. Damaged longitudinal sills, or parts thereof, must be repaired, or spliced, in accordance with the following specifications where practical and more economical than renewal. In such cases, if sills or parts thereof are renewed, charge may not exceed the cost of splicing.*

Reason: To confine repairs to minimum expense necessary in accordance with recognized general practice.

Rule 23

The committee recommends that effective date of requirement prohibiting the welding of cast-steel truck side frames having "T" or "L" section compression or tension members, now set at January 1, 1941, be extended to January 1, 1942.

Reason: To harmonize with extension recommended under Rule 3.

Rule 44

The committee recommends that this rule be revised as follows:

Proposed Form: (2) Composite *wood* and steel underframe cars. When five or more steel or *wood* longitudinal sills are damaged *within the space between bolsters,* providing three or more are broken entirely new at point of breakage.

(3) All-steel underframe cars having but one steel center *sill. When broken wholly or in part within the space between bolsters, or* when bent *within such space* in excess of *2½* inches. *Where failure of such sill is* due to progressive fracture back of body bolster, or failure of cast-steel extension (draft arm), *it will be owner's responsibility.*

(4) All-steel underframe cars having two or more longitudinal sills.—When two center sills, *within the space between bolsters are:*

(a) Both broken wholly or in part, or

(b) When each is bent in excess of 2½ inches, or

(c) When one is broken wholly or in part, and the other is not broken but is bent in excess of 2½ inches.

(5) (Vacant.)

Note A. Draft members, wood or steel, extending from end sill to end sill and used to reinforce center sills, are not longitudinal sills.

Note B. The bending of steel center sills in excess of 2½ inches does not refer to sagging or bowing, but to definite buckling or abrupt bends. The term "between bolsters" means from rear edge of body bolster at one end of car to rear edge of body bolster at opposite end of car.

Note C. When the damage is confined to the steel center sills within the space from end sill to bolster, car owner will be responsible, providing after investigation it is found that car was not subjected to unfair handling as provided by Paragraphs (a), (b), (c), (e), (f), (o), or (q) of Section (10) of Rule 32.

Reason: To provide a more explicit definition of the defects and a more practical method of determination in interchange inspection.

Rule 49

The committee recommends that last sentence of Section (a) of this rule be relocated as new Section (b) and revised, present Sections (b), (c), and (d) to be relettered as Sections (c), (d) and (e), as follows:

Proposed Form: (b) Where receptacle is used, same should be in accordance with A. A. R. Recommended Practice specifications, applied one per car, preferably located *on outside of car as specified in following Paragraphs (1), (2) and (3), not more than 5 ft. 6 in. from top of rail. However, if located underneath the car, it should be applied on cross bearer nearest center of car, not more than 12 inches from side sill. Cars having fish belly side sills should not have the receptacle underneath the car.*

Present paragraphs (1), (2) and (3) of Section (a) to be relocated as paragraphs (1), (2) and (3) under new Section (b).

Present Sections (b), (c) and (d) to be relocated as new Sections (c), (d) and (e).

Reason: To definitely prescribe location for defect card receptacle, in order to conserve time in transportation yards.

RULE 60

The committee recommends that air brake markings be modified to show *reporting marks* instead of *initials* of roads, by eliminating the word *"road"* shown on the cylinder in cuts on pages 122 and 123 and changing caption to read "Stencil here *reporting marks* of road" instead of "Stencil here *initials* of road."

Reason: To reduce stenciling. This recommendation is concurred in by the Committee on Brakes and Brake Equipment.

The committee recommends that a new Paragraph (n) be added to this rule, effective August 1, 1940, to read as follows:

(n) Charge for cleaning of AB type freight brake equipment within time limits specified by this rule, is not permissible account renewal of pipe and pipe fittings, duplex release valve parts shown in Item 27 of Rule 111, vent protector, brake cylinder, brake reservoir, combined dirt collector and cut-out cock, branch pipe tee, retaining valve, or parts of these items. Charge for separate COT&S of emergency or service portion is not permitted.

Reason: COT&S of operative AB brake equipment is unnecessary in connection with renewal of above items. This recommendation has the concurrence of the Committee on Brakes and Brake Equipment.

RULE 75-A

The committee recommends that first paragraph of this rule be modified in the next supplement, as follows:

Proposed Form: Rule 75-A. Combination tread defects—shelled out, flat spots, brake burn comby spots: Cast-iron wheels having *three* or more defects not more than three inches apart and extending circumferentially on tread for a distance of 12 in. or more, etc.

Reason: To clarify the intent.

RULE 78

The committee recommends that second paragraph of this rule be modified as follows:

Proposed Form: Rim, broken—cast-iron and cast-steel wheels: (a) If the width of tread measured from flange at a point 5/8 in. above tread, is 3½ in. or less (see Fig. 5); or, (b) If width of tread, measured from flange at a point 5/8 *in.* above tread, is *3¾ in. or less* and the fracture through rim inclines inwardly toward plate (see Fig. 5-A). Measurements to be made with gage shown in Fig. 1, and applied as shown in Figs. 5 and 5-A. See Paragraph 115 and Figs. 97 to 99 in Wheel and Axle Manual.

Reason: To clarify the intent and harmonize with Rule 82 as recommended by the Committee on Wheels.

RULE 98

The committee recommends that first sentence of Paragraph (5) of Section (c) of this rule be modified as follows:

Proposed Form: (c-5) Serviceable experimental cored hub wheels marked "A. A. R. X." when removed from service on account of defect in axle or mate wheel, shall be credited as scrap except when removed on account of Rule 32 *or Rule 84* condition in which event second-hand credit must be allowed for such undamaged wheel *or wheels.*

Reason: Car owner is entitled to protection in cases of wheels removed due to cut journals.

RULE 104

The committee recommends that Item 11—Journal Boxes under Section (1) of this rule be eliminated, Item 16 reading "Truck sides" be modified to read "Truck sides, U section," and last paragraph and note be relocated as new notes under new Section (m) and modified; the new section and notes to read as follows:

(m) The following items of material, when applied in repairs to owner's defects or on authority of defect card, must, if secondhand, be charged at 30 per cent of gross value new, less credit for part removed:

1. Journal boxes.

2. Truck sides, "T" and "L" section.

Note 1.—When items *specified in Sections (l) and (m)* are applied, the billing repair card must show whether new or secondhand. If secondhand, the material charge must be shown in "net price" column on billing repair card. If defect card covering labor and secondhand material is issued account of wrong repairs to owner's defects, in the correction thereof bill on authority of defect card must be confined to secondhand value, regardless of whether new or secondhand material is applied. Such defect cards should so specify if secondhand material is applied.

Note 2.—Where Rule 101 quotes net price, 50 per cent of such net price for *items in Section (l), and 30 per cent for items in Section (m)*, shall be used and no credit allowed for scrap.

Reason: Due to elimination of arch bar trucks and accumulation of journal boxes as result thereof, and obsolescence of the "T" and "L" section side frames, it is felt the charge for such secondhand parts should be reduced.

RULE 108

The committee recommends that 23rd item under Section (a) of this rule (which prohibits labor charge) be modified as follows:

Proposed Form: Release lever bracket or support, straightened on car.

Reason: No charge is now permitted for straightening release lever bracket support. It is felt the same principle should consistently be extended to cover the release lever bracket.

RULE 112

The committee recommends that Paragraph 5 of Section A of this rule be modified, effective August 1, 1940, as follows:

Proposed Form: A-5. Age of car shall be determined by subtracting year and month in which car was originally built, or rebuilt, from year and month in which car was destroyed, which will give the life in years and months. No fractional part of a month shall be considered. The age of trucks shall be the same as that of the car body. *However,* where new or secondhand tank is applied to a tank car subsequent to original date car was built; *or secondhand tank is applied to complete new underframe (including attachments) and complete new trucks (except that the following items of secondhand material may be used; couplers, draft gears, wheels, axles and AB brakes exclusive of pipe and pipe fittings), and providing that car complete including secondhand details conforms with all A. A. R. interchange requirements for new cars in effect at date of construction;* depreciation on such tank shall be computed from date tank was built new, and depreciation on remainder of car shall be computed from date *underframe (including trucks) was built new.*

Reason: Effective August 1, 1939, Rule 112 was modified to provide separate depreciation for tanks renewed on existing underframes and trucks. The same principle should consistently be extended to the reverse operation.

DEFECT CARD FORM

The committee recommends that the words *"Must not have carbonized back" be added to the defect card form on page 260, similar to the billing repair card form.*

Reason: The use of the carbonized back is objectionable for filing purposes. As a measure of economy and to promote uniformity.

Passenger Car Rules

RULE 4

The committee recommends that the effective date of second paragraph of this rule, with reference to equipping all-steel or steel underframe cars with cardboards or suitable receptacle for the accommodation of defect and joint evidence cards, now set at January 1, 1941, be extended to January 1, 1942.

Reason: The present situation justifies this extension.

RULE 9

The committee recommends that present note following Section (f) of this rule be eliminated and a new Section (g) added, effective August 1, 1940, as follows:

Proposed Form: (f) Note. (Vacant.)

(g) *(1) Air Conditioning Equipment. Labor and material expense for ice, water, lubricants, steam, fuel for internal combus-*

tion engines, and cost of precooling cars, including electric current supplied, also labor of all daily and periodic testing and inspecting and all other items of servicing.

Proposed Form: (2) Cost covering the above shall be agreed to by the parties involved and be charged only at the originating terminals of established line. Ice furnished ice-activated cars at intermediate terminals is also chargeable to the line.

(3) All repairs made are chargeable direct to car owner, including charging and flushing of batteries, and Freon or similar refrigerant supplied.

Reason: The line service items enumerated are special expense of the originating terminal that should be borne by all parties to the line on a prorata mileage basis.

Rule 10

The committee recommends that Item No. 6 of this rule be modified, effective August 1, 1940, as follows:

Proposed Form: Rule 10. Interchange Service expense items to be assumed by handling line, are as follows:

6. Air conditioning equipment: *Expense items outlined in paragraph (g) of Rule 9 shall be assumed by handling line.* All repairs made are chargeable *direct* to the car owner, including charging and flushing of batteries, *and Freon or similar refrigerant supplied.*

Reason: To harmonize with recommended revision of Passenger Rule 9.

The report was signed by W. H. Flynn (chairman), general superintendent motive power and rolling stock, N. Y. C.; J. P. Morris (vice-chairman), mechanical superintendent, A. T. & S. F.; R. G. Bennett, general superintendent motive power, Pennsylvania; A. E. Smith, vice-president, Union Tank Car Co.; J. A. Deppe, superintendent car department, C. M. St. P. & P.; L. Richardson, mechanical assistant to vice-president and general manager, B. & M.; G. E. McCoy, assistant general superintendent car equipment, C. N. R., and M. F. Covert, general superintendent of equipment, General American Transportation Corp.

In presenting the report Chairman Flynn referred to the revision of paragraph 4, Section (b), of Rule 1 and presented a note defining "lower loading classification" which, he said, was to be included in the revision. The note reads as follows: "Cars of 'lower loading classification' refers to cars the general condition of which is such that extensive repairs would be required to place them in suitable condition for Class A loading. Miscellaneous minor repairs to damaged portions of flooring, roofing, sheathing, lining or doors on cars required for, and which are otherwise suitable for Class A loading, is not prohibited."

The report was accepted.

Report on Labor and Material Prices

In order that the rules may currently provide an equitable basis for inter-road billing, the committee continued the work of analyzing material, labor and new equipment costs in A. A. R. Interchange Rules 101, 105, 107, 111 and 112 of the Freight Car Code, and Rules 21 and 22 of the Passenger Car Code, with a view of determining and recommending necessary changes to be made in the next supplement to the current Code.

Freight Car Rules

Rule 101

All miscellaneous material prices in Rule 101 were rechecked as of March 1, 1940, quotations submitted by the purchasing agents of the ten selected railroads, representing 39 per cent of total freight car ownership in the United States and Canada, showing a slight downward trend in material markets as indicated by detail recommendations for revisions shown under this rule.

The allowance of two per cent which has been added to material quotations in the past to represent interest on stock investment was based on a turnover every four months at six per cent per annum. Investigation discloses that under present conditions the more common items of car repair material are turned over every two months. It is recommended, therefore, the allowance be reduced to one per cent effective August 1, 1940, and material prices listed under this rule have been so computed.

A study is under way on nineteen selected railroads representing all portions of the United States and Canada, through the Purchases and Stores Division, to ascertain if the present ten per cent allowance for store expense used in the make-up of A. A. R. material prices, is equitable. If any modification is found necessary, revision will be made and included in the Rules effective January 1, 1941.

New Item 129-C is added, to provide charge for Type E coupler knuckle lock made of high tensile steel.

One new conditionally approved type of draft gear, Waugh-Clark 150-B, has been added to Section I of the draft gear table. One additional type has been added under the obsolete classification in Section III.

Rule 105

Interpretation No. 1 to this rule has been modified to reduce from 15 to 12 per cent the allowance that may be added to the factory price of manufactured articles to cover store expense, interest on stock investment and freight haul, to harmonize with formula used in setting up A. A. R. material prices appearing in other rules.

Rule 107

Based upon studies recently conducted, the allowances for bolts under Items 30 and 31, and rivets under Items 291 and 292, have been materially reduced.

New Item 47-B and note are added to provide labor charge for coupler shims described in Figs. 2 and 3 of Rule 20 and to clarify the intent that the charge for removal and replacement of couplers in order to apply any of the various types of shims shown in Rule 20 is not proper.

Items 93, 147 and 158 have been modified to clarify the intent and provide charge for drive screws and floor rack stringers.

Item 98 is modified to increase the allowance for jacking loaded cars, based on time studies in the field conducted under the direction of the committee.

Item 281 is modified to provide a more equitable allowance for annealing parts which have been welded, as result of time studies in the shops of railroads and private car lines represented on the committee.

Items 280 and 294, also as result of studies made in various railroad and private line shops, have been modified to provide a more equitable basis of charging for repairing and straightening of parts off car.

The committee has arranged to conduct time studies in the field of a number of operations, principally truck repairs, to ascertain if present allowances appearing in this rule are equitable under present day conditions on modern repair tracks. Any adjustments necessary will be incorporated in the Rules effective January 1, 1941.

Rule 111

No modifications are recommended in this rule.

At the time studies were conducted on which the present allowance for AB brake equipment was formulated, investigation was necessarily confined to the initial cleaning operation. The second cleaning cycle has now been reached for a considerable number of such brakes, which undoubtedly will involve the renewal of an increased number of detail parts. Arrangements have been made to conduct studies on various railroads of the cleaning operation, to include a reasonable percentage of brakes due for second cleaning, and any adjustment necessary will be made in the 1941 Code.

Rule 112

Recommendations are made in this rule respecting reproduction pound prices of new freight cars of all classes, in order that Supplement of August 1, 1940, may reflect 1939 costs in lieu of figures shown in the present Code. New prices recommended are based on costs of 16,889 freight cars constructed during the year 1939.

The table listing all-steel tank cars has been modified to provide a more definite separation between insulated and non-insulated tank cars, and inclusion of the higher pressure requirement cars with other special types to be settled for on reproduction cost basis.

Passenger Car Rules

Rule 21

Item 26 modified and first note following eliminated to provide an allowance for turning wrought-steel and steel-tired wheels equipped with certain types of roller bearings which necessitate additional work in order to perform the operation.

Rule 22

Material prices were rechecked on basis of quotations as of March 1, 1940, showing a slight downward trend as indicated by detail recommendations for revisions shown under this rule.

Note following Item 49 modified to clarify the intent.

It is the intent of the committee to investigate labor and material costs again in October and if sufficient change develops, necessary revisions will be made and inserted in the rules effective January 1, 1941.

[The changes recommended in the existing rules are shown in detail in the report.]

Supplementary Report

[Note: This supplementary report, presented at the time of the meeting, not only recommends additional changes but alters, in some respects, the recommendations of the original report, as abstracted above—Editor.]

As a result of time studies just completed on five railroads in sufficient volume to warrant modification of a number of labor allowances, your Committee recommends additional changes in Rules 101, 107, 111 and Passenger Rule 21.

Freight-Car Rule 101

The labor allowance for renewal of dust guards has been absorbed in the allowances for wheels, truck sides and journal boxes. Accordingly, the wording of Item 169-A is modified to indicate an applied price and the labor allowance in Rule 107 eliminated.

Freight-Car Rule 107

Item 20 covering renewal of brake beams, is modified, and new Item 20-A added, to provide separate allowances for beams renewed separately versus those renewed in connection with truck bolster, truck side or wheels in unit type trucks, which it is felt will provide a more equitable method of charging.

Item 102 covering labor charge for journal box dust guards is eliminated, account labor absorbed in the allowances for wheels, truck sides and journal boxes.

Items 239, 240, 241 and 265 covering stenciling operations are clarified, allowances modified and the latter two items relocated as news Items 240-A and 241.

Item 256 covering renewal of truck springs, caps or shims, has been modified to include necessary jacking for this operation and separate allowances set up for empty and loaded cars.

Based upon the studies recently conducted, in addition to the above mentioned items, modifications are recommended in the allowances under Items 14, 42, 43, 44, 45, 48, 49, 138, 143, 153, 254, 255, 267, 268, 269, 270 and truck combination labor charges under Items 317 to 325 inclusive.

Freight-Car Rule 111

Based upon studies recently conducted, which included a representative number of valves undergoing second period attention, the allowance in Item 15 for COT&S of AB freight brake equipment is materially reduced.

Passenger-Car Rule 21

Item 25-B is modified to reduce allowance to be deducted when wrought-steel wheels are removed and dismantling operation is unnecessary.

The report was signed by A. E. Calkins (chairman), superintendent of equipment, N. Y. C.; A. E. Smith (vice-chairman), vice-president, Union Tank Car Co.; J. D. Rezner, general car foreman, C. B. & Q.; P. Kass, superintendent car department, C. R. I. & P.; T. J. Boring, general foreman, M. C. B. Clearing House, Pennsylvania; H. H. Boyd, assistant chief motive power and rolling stock, Can. Pac., and A. H. Gaebler, superintendent car department, General American Transportation Corp.

The report was accepted.

Report on Specifications for Materials

During the past year this committee has reviewed the material specifications, giving consideration to comments and criticisms submitted by the members of the association, and others.

The following revisions are submitted for your consideration:

1—Specifications M-102-34, forgings carbon steel, annealed and unannealed.—In order to clarify interpretation, changes to be made as follows: Page 1, Sec. 1. Scope.—(a). Last sentence to be revised as follows: "Grade 3 forgings are generally used for locomotive axles, side rods, crank pins, guides, etc." Page 1, Sec. 1. Scope.—(c). To be revised as follows: "Unless otherwise specified, Grades 1 and 2 forgings will be furnished unannealed, and Grade 3 forgings will be furnished annealed." Page 2, Sec. 7. Chemical Composition—Grade 3 requirement for Manganese: change 0.50—0.90 per cent to 0.60—0.90 per cent.

2—Specifications M-108-37, boiler tubes, lap-welded and electric resistance welded seamless steel and lap-welded charcoal iron.—This specification has been revised as a whole, and the recommended revised specification is identified as Exhibit A (not shown in the present abstract of the committee's report). The principal changes are as follows: (a) To conform to present practice in the steel industry, the tables have been modified on the basis of wall thickness expressed in decimals of an inch in place of Birmingham wire gage. (b) At the recommendation of the Committee on Locomotive Construction, the scope of the specifications has been changed to include dry pipes and steam pipes for locomotives, to dimensions shown in Table II, to replace the figures for dry pipes shown in the Manual, Sec. F, page 6A, 1924.

3—Specifications M-109-36, structural rivet steel and structural rivets.—Specifications M-110-36, boiler rivet steel and boiler rivets. Consolidation of specifications M-109 and M-110 is recommended and draft of the proposed consolidated specification, designated as M-110-40, is identified as Exhibit B (not included in this abstract of the committee's report).

4—Specifications M-119-34, galvanized sheets.—Changes to be made as follows: Page 2, Sec. 5 (c) Table I. Insert U. S. standard gage No. 15; nominal thickness of base sheet, .070 in.; weight of galvanized sheet, ounces per sq. ft., 45.1 min., 47.5 nominal, 49.9 max.; minimum weight of coating, 1.75 ounces per sq. ft.

5—Specifications M-302-37, refined wrought iron bars.—Changes to be made as follows: Page 2, Sec. 5 (a): Heading of second column to be changed to read "Round, Square and Hexagonal Bars 1⅝ in. and up to but not including 2½ in. in diameter or thickness." Add small letter "c" in third column opposite tensile strength requirements for both Grades A and B. Change present footnote reference "a" to read, "Bars from ½ in. to ⅞ in. in diameter will be accepted if the elongation in 8 in. is not less than 25 per cent for Grade A, or 22 per cent for Grade B material"; and add additional sentence to footnote reference "a" to read: "Bars under ½ in. in diameter will be accepted if the elongation in 8 in. is not less than 22 per cent for Grade A and for Grade B material." Add footnote reference "c" to read, "c When the sectional area exceeds 12 sq. in. the allowable minimum tensile strength shall be 45,000 lb. per sq. in."

6—Specifications M-603-38, hose, air, gas and oxygen, wrapped and braided.—Changes to be made as follows: Page 4, Sec. 15 (b) to be revised as follows: "(b) For braided hose, the inside diameter may vary either way from that specified by not more than $\frac{3}{128}$ in. for the ¼ in. size; $\frac{1}{32}$ in. for sizes larger than ¼ in. up to and including ¾ in.; and by not more than $\frac{1}{16}$ in. for larger sizes."

7—Specifications M-904-36, renovated car oil.—This specification as submitted by the Joint Sub-Committee on Journal Box Lubricating Materials has been studied and approved, and it was agreed that the Committee on Lubrication should include it in that committee's annual report.

This committee recommends that the above revisions in specifications be approved for submission to letter ballot.

The report was signed by T. D. Sedwick (chairman), engineer of tests, C. R. I. & P.; E. E. Chapman (vice-chairman) mechanical assistant, A. T. & S. F.; Frank Zeleny, engineer of tests, C. B. & Q.; H. G. Burnham, engineer of tests, Nor. Pac.; H. P. Hass, engineer of tests, N. Y., N. H. & H; J. R. Jackson, engineer of tests, Mo. Pac.; H. G. Miller, engineer of tests, C. M. St. P. & P.; J. W. Hergenhan, assistant engineer, test department, N. Y. C.; L. B. Jones, engineer of tests, Penn.; C. B. Bryant, engineer of tests, Southern; and W. R. Hedeman, engineer of tests, B. & O.

The report was accepted and submitted to letter ballot.

Locomotive Construction

Design of Fundamental Parts of Locomotives

Wheel Centers of the Thin Wall Type

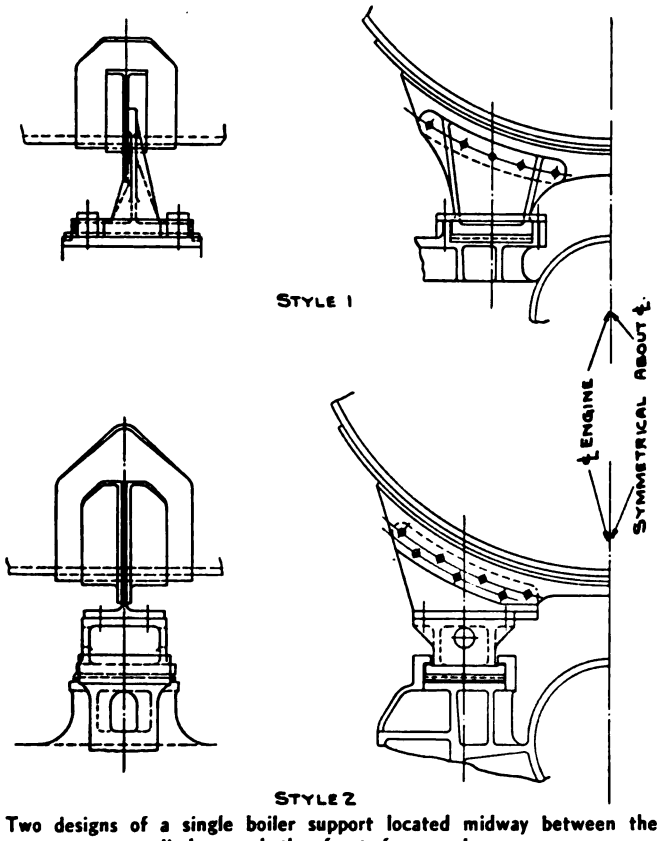
The Committee decided to continue report made last year and show defects that have developed in the various types of wheel centers.

Report following shows all defects from date of application up to April 30, 1940. This information is given for the benefit of member roads as well as benefit of manufacturers in discovering defects in designs and making necessary corrections for overcoming same.

[The report includes tabular details of failed wheel centers. A summary of such failures appears in Table I—Editor.]

Table I—Summary of Failures of Thin-Wall Driving Wheel Centers

Manufacturer	Total number of wheels in service	Total defective	Per cent defective
No. 1	1,086	77	7.0
No. 2	8,499	52	.61
No. 3	340	11	3.2
No. 4	1,267	17	1.3
No. 5	833	4	.48



Two designs of a single boiler support located midway between the cylinders and the front furnace bearer

Multiple Bearing Crossheads

The sub-committee was requested to prepare proposed designs to be added to the Manual as recommended practice for multiple bearing crossheads.

Two different designs are shown in the report and it is the intention of the committee to have both placed in the Manual so that individual roads can select the type desired.

It is recommended that this be submitted to member roads by letter ballot for inclusion in the Manual as recommended practice.

Furnace and Firebox Support and Boiler Waste Sheets

In 1938 a test was made jointly by the Baldwin Locomotive Works and the General Steel Castings Corporation on a locomotive then under construction in the Baldwin plant having one-piece cast-steel bed. This test was made to determine the effect of waist sheets or other attachments between frame and boiler from the front of the firebox to smoke box connection.

The sub-committee went over report of this test and for the information of member roads we are quoting below conclusions reached by the Baldwin Locomotive Works and General Steel Castings Corporation as result of this test:

"The waist sheet bearer at the guide yoke results in a high reaction downward through the sheet which gives a peak in the bending moment curve at this point. From the diagram it does not appear that this waist sheet is contributing much to the vertical resistance.

"It is possible, particularly on a locomotive bed casting, to cast a bracket of ample strength integral with the bed which would withstand the upward thrust of the crosshead so that the necessity of waist sheet at this point is questioned.

"The waist sheet in front of the rear drivers appears to offer more resistance than other waist sheets, causing deflection. This is evident, since the effect of a reaction is to level out the bending moment curve and tests indicate that this support while not unyielding, nevertheless offers resistance to vertical deflections.

"The front and rear furnace bearers react closely to the calculated values and it is evident that a broad base bearing of this type is most effective in withstanding vertical thrusts.

"The final conclusions reached are that it does not appear that eliminating all connections between frame and boiler from firebox to smoke box saddle is advisable. It is therefore suggested that a single boiler bearing located midway between cylinders and front furnace bearer, say between main and intermediate drivers, would offer maximum support to vertical deformations and minimize the stresses in the region immediately rear of the cylinders. The bearing should have sufficient rigidity to withstand vertical impact without yielding, at the same time provisions should be made for longitudinal expansion of the boiler. This could be obtained with a sliding shoe bearing which would offer a large bolting flange to cradle the boiler and provide a low unit pressure on the sliding surface, insuring positive resistance at all times."

One member road built some locomotives in 1937, others in 1939, with a single boiler support midway between cylinders and front furnace bearer, (Style 1). Another road is now rebuilding some locomotives with a single support (Style 2).

Exhaust Steam Injectors and Exhaust Steam Feedwater Heaters

The sub-committee has continued the study of exhaust steam injectors and in addition exhaust steam feedwater heaters and was instructed to submit informative report covering reliability, maintenance, service, etc., of both, the exhaust steam injectors and exhaust steam feedwater heaters.

Manufacturers of respective equipment advised the application of their product to locomotives in the United States and Canada as follows:

Exhaust steam injectors	1,200	(2 mfgrs.)
Exhaust steam feedwater heaters, closed heater, pump type	5,160	(2 mfgrs.)
Exhaust steam feedwater heaters, open heater, pump type, including turbo injectors	3,893	(3 mfgrs.)
Total	10,253	

In response to a questionnaire sent out by the secretary, so-

liciting information to develop comparative reliability, maintenance and service data from roads using above injectors or heaters, replies were received from 36 railroads on injectors and from 53 railroads on heaters. Most railroads reported in detail as requested, only a few stating that no information was available.

All types of devices as reported employ exhaust steam for raising temperatures of the boiler feedwater. In the open-type heater, the condensed exhaust steam forms a part of the boiler feed, same as the exhaust steam injector, whereas in the closed type heater, the exhaust steam does not contact the feedwater.

[The report includes statements covering results of data requested, the number of failures, delays, as well as maintenance costs, etc., being based on performance of years 1937, 1938 and 1939, as this three year period indicates the general prevailing condition.—EDITOR.]

The boiler pressure of locomotives equipped with exhaust steam injectors varied from 170 to 300 lb. per sq. in. and of locomotives equipped with exhaust steam feedwater heaters from 175 to 310 lb. per. sq. in.

As to inquiry of questionnaire reading "Has the use of exhaust steam injectors or heaters had any effect on boiler maintenance," most replies indicate that devices reported have generally not been in service a sufficient length of time to notice a definite effect while a few claim small savings on boiler maintenance with extent unknown. Also as to the inquiry, "In bad water districts is the fuel and water saving reduced because of scaling condition," replies indicate that open heaters are not affected while closed heaters are affected with extent depending on condition.

The sub-committee desires to continue its studies on the economies of the various types injectors and heaters as now used in order to develop more accurate maintenance and repair costs, differentiating between running and classified repairs, both labor and material.

The secretary will be requested to issue a questionnaire to members covering a record of such expenditures for period July 1, to December 31, 1940.

Development and Use of Oil-Electric Locomotives

The committee on the Development and Use of Oil-Electric Locomotives has continued to assemble information as to the use of this type of equipment, has brought up to date all information previously assembled by adding thereto units placed in service during the year 1939, and has also included in the report a statement showing those units on order as of January 1, 1940.

On December 31, 1939 there were 749 Diesel units in operation. 250, or approximately 33 per cent of the total were placed in service during the year 1939 by 52 railroads and operating companies. The installations during that year exceeded the installations of any previous year by 61 per cent.

Our study also developed that up to and including the 1939 report there were 122 railroads and operating companies operating Diesel locomotives as compared with 99 as of December 31, 1938, an increase of 23, and as a further indication of the extended use of this equipment during the year 1940, the committee found that on January 1, 1940 there were 57 Diesel locomotives on order for 16 railroads and operating companies.

The previous report of the Committee indicated that there were 23 units of 2,000 hp. or larger operated in combination on various railroads, making a total combined horsepower of from 2,000 to 6,000, which units, for the purpose of this report, have been considered as one Diesel-electric locomotive, and during the year 1939 there were 21 additional Diesel locomotives in this classification placed in service.

Continuing the previous tabulation designed to show the diversified use of the Diesel locomotive, the following table indicates the number of Diesel locomotives of varying horsepower that have been placed in service prior to December 1, 1939:

Horsepower	Delivered 1939	Delivered Prior to 1939	Per Cent Increase During 1939
Less than 300	2	23	8.6
300 to 600	13	118	11.0
600 to 900	132	235	56.1
900	7	73	9.5
950 to 6,000	96	50	190.0

It is particularly noted that of a total of 250 units placed in service during the year 1939, 107 were of 600 hp. and 73 were of 1,000 hp. In previous years the 600 hp. seemed to have enjoyed the most general adoption, but during 1939 there was a decided trend toward 1,000 hp. units; 73 being placed in service, whereas prior to 1939 only 4 of this horsepower were in use.

[The report includes two tables showing the Diesel locomotives in service, classified by year and horsepower over a 15-year period, and by class of service.—EDITOR.]

During the year the railroads were canvassed in an effort to assemble information as to availability, lubrication and fuel oil consumption, cost of repairs and with special request to distribute the cost of repairs between electrical and Diesel equipment. From the reports of ten selected railroads the results of this six months operation on seventy-one 600 hp. Diesel-electrics and twenty-seven 900 hp. Diesel-electrics are tabulated on Table II. This table is of interest since it shows the variation in cost between various railroads and the average combined total for the railroads in each group.

The locomotives considered are of various ages and there is a considerable number of recent construction included, which, in part, accounts for the variation in maintenance costs, but the information reference availability, lubricating and fuel oil performance shows less variation and indicates what the railroads are finding in actual operation.

A question has been raised with reference to the relation of the cost of maintaining the electrical and Diesel equipment. For the 600 hp. units it was developed that the cost of maintaining the electrical equipment is approximately 18 per cent of the total and this expense is divided about 82 per cent labor and 18 per cent material. The cost of maintaining the Diesel equipment is approximately 59 per cent of the total and this expense is divided about 65 per cent labor and 35 per cent material. With

Table II—Record of Diesel-Electric Locomotive Operation and Maintenance Cost of Selected Railroads for a Six Months' Test Period

Railroad index	No. of units	Hours assigned	Hours operated	Per cent of assignment operated	Gallons lub. oil Total	Gallons lub. oil Per hour	Gallons fuel oil Total	Gallons fuel oil Per hour	Cost of Repairs: Electrical equipment Labor	Electrical equipment Material	Diesel equipment Labor	Diesel equipment Material	Total	Per loco. hour
600 hp.														
1	4	16,748	16,748	100.00	1,307	.0780	98,602	5.887	$772.70	$204.18	$2,382.40	$834.08	$4,193.26	.2504
2	6	24,736	24,347	98.43	4,483	.1841	133,567	5.486	508.94	18.01	2,732.25	1,931.80	5,369.12	.2205
3	29	121,975	115,504	94.69	15,181	.1314	589,177	5.101	2,853.10	907.07	8,295.00	4,387.84	19,705.12	.1706
4	5	20,527	19,029	92.70	2,622	.1378	91,120	4.788	1,193.02	451.04	1,588.16	1,569.36	7,195.72	.3781
5	14	61,152	39,989	65.39	7,122	.1781	322,620	8.068	4,301.06	413.91	9,772.10	5,083.78	28,940.08	.7237
6	6	26,208	22,073	84.22	2,138	.0969	126,045	5.710	*	*	*	*	6,663.07	.3019
7	3	12,545	11,814	94.17	1,502	.1271	62,040	5.251	*	*	*	*	4,648.00	.3934
8	4	15,472	13,364	86.38	1,202	.0899	56,738	4.246	*	*	*	*	3,139.51	.2349
TOTAL	71	299,363	262,868	87.81	35,557	.1353	1,479,909	5.630	$9,628.82	$1,994.21	$24,769.91	$13,806.86	$79,853.88	.3038
Average	..	4,216	3,702	87.81	501	.1353	20,844	5.630	.....	.....	.....	.....	1,124.70	.3038
900 hp.														
2	3	8,332	7,903	94.85	1,680	.2126	62,283	7.881	$151.03	$234.85	$1,153.44	$1,025.99	$2,578.29	.3262
3	8	34,101	31,942	93.67	4,255	.1332	188,002	5.917	1,524.86	312.21	2,738.80	481.75	6,229.18	.1950
4	3	12,529	11,869	94.73	1,664	.1402	81,159	6.838	913.21	117.87	2,407.21	2,101.98	6,373.15	.5370
9	2	8,056	7,745	96.14	2,172	.2804	53,778	6.944	150.34	13.59	637.93	1,505.69	3,076.93	.3973
10	2	8,736	8,254	94.47	2,279	.2761	63,918	7.744	*	*	*	*	2,017.79	.2445
6	9	39,312	34,049	86.61	4,296	.1262	198,210	5.821	*	*	*	*	7,757.55	.2278
TOTAL	27	111,066	101,762	91.62	16,346	.1606	648,350	6.371	$2,739.44	$678.52	$6,937.38	$5,115.41	$28,032.89	.2755
Average	..	4,114	3,769	91,62	605	.1606	24,013	6.371	.....	.....	.....	.....	1,038.26	.2755

* Information not available.

Table III—Applications of Roller Bearings in the United States and Canada

	Timken	SKF	ASF	Hyatt	Fafnir	All
Total engine trucks equipped	556	489	87	0	0	1,132
Total main drivers equipped	387	63	0	0	0	450
Total other drivers equipped	387	51	0	0	0	438
Total all drivers equipped	387	44	0	0	0	431
Total trailer trucks equipped	309	120	100	0	0	529
Total tender trucks equipped	495	279	176	10	9	969
Total eng. trk. bearings applied	2,084	1,926	348	0	0	4,358
Total main driver bearings applied	850	146	0	0	0	996
Total other driver bearings applied	2,366	232	0	0	0	2,598
Total all driver bearings applied	3,216	378	0	0	0	3,594
Total trailer trk. bearings applied	1,118	494	390	0	0	2,002
Total tender trk. bearings applied	5,896	3,420	2,112	116	108	11,652
Per cent of total eng. trk. bearings applied	47.82	44.194	7.985	0	0	.....
Per cent of total main driver bearings applied	85.341	14.658	0	0	0	.....
Per cent of total other driver bearings applied	91.07	8.92	0	0	0	.....
Per cent of total trk. bearings applied	55.844	24.675	19.48	0	0	.....
Per cent of total tender bearings applied	50.60	29.351	18.125	0.995	0.926	.....
Per cent bearings reported of total number applied, e. t.	69.481	64.382	47.126	....	....	.....
Per cent bearings reported of total number applied drivers	48.569	95.238	....	....	....	.....
Per cent bearings reported of total number applied trl. trk.	59.391	71.659	30.769	....	....	.....
Per cent bearings reported of total number applied tender	62.754	69.59	23.295	100.00	22.222	.....

the 900 hp. units there was a slight variation in the percentages, although this is undoubtedly due to the variation in the average age of the units considered.

Attention is directed to the total hours operated for six months period by the seventy-one 600 hp. units. 3,702 hours per unit during this period is 87.81 per cent of the continuous assignment of 24 hours per day and represents 20.2 hours actually operated each calendar day, which is an indication of the availability of this equipment.

The information as to estimated cost of repairs over considerable periods of operation is quite clearly set forth in the committee's 1939 report. With the additional information contained in this report as to availability, lubricating and fuel oil performance and distribution of cost of repairs between electric and Diesel equipment, it is felt that sufficient information is available to justify consideration of suspension for the present at least of activities of this committee and it is so recommended.

Table IV—Relative Maintenance Costs of Friction vs. Roller Bearing Locomotives

Key No.	Dr.	E.T.	T.T.	Tender	Loco. maintenance costs per mile (labor and material) Per engine of classes reported: Friction	Roller	Average monthly mileage per class: Friction	Roller	Type of loco.
3	x	x	x	x	.2327	.1452	7,754	15,538	4-6-4
6	x	x	–	x	.2514	.1611	2,055	6,182	2-10-4
6	x	x	x	x	.1645	.1035	6,062	9,611	4-8-4
10	–	x	x	–	....	....	9,950	10,800	....
15	–	x	–	–	.217	.209	8,500	8,500	....
18	–	–	–	–	.186	.130	4,300	7,600	....
19	Ma.	–	–	–	....	....	4,700	6,500	4-6-2
21	x	x	x	x	.1465	.1288	7,350	8,900	4-8-4
24	x	x	–	x	....	....	7,000	7,000	....
26	x	x	x	x	....	....	6,516	7,714	....
29	–	–	–	–	.2033	....	....	....	....
29	–	–	–	–	.1448	....	....	....	....
29	–	–	–	–	.1708	....	....	....	....
30	x	x	x	–	....	....	6,000	11,000	4-6-2 / 4-6-4
33	x	x	x	x	.402	.204	4,105	6,554	2-8-8-2
38	x	x	x	x	....	....	6,093	7,791	....

Replies to questionnaire as to difference in maintenance cost (labor and material) of bearings, driving boxes, hub liners, etc., of engines equipped with roller bearings versus friction bearings, indicate that roads did not keep a record of such costs and only a few roads replied to the inquiry.

Standardization of Valves for Locomotives

Since the A. A. R. Standard valves were adopted as recommended practice, the committee has endeavored to secure information as to the service rendered by the valves and the possibility of improvement in the design or the materials of which the valves are made.

In response to a questionnaire issued for this purpose, the railroads report generally that the service obtained is superior to that obtained from other than A. A. R. valves, but that some minor difficulties have been encountered, which are being given consideration by the committee.

On valves of the outside screw and yoke type, used in locations requiring frequent operation of the valve, there have been some cases of stripping of the bonnet threads, the bonnet being made of bronze and the stem of stainless steel. To overcome this difficulty and to improve the construction of the valve, the committee has developed the design of bushing with locknut for application in the bonnet as shown on Pages F-174A, 174B and 174C, which is now submitted as recommended practice for new or repaired bronze O. S. & Y. type valves.

The material specification has been revised to include this bushing and locknut, and also to increase the Brinell hardness of the seat ring and disc on all valves from 175 to 225, which is considered more satisfactory for these parts.

The committee still has under consideration the proposed standard valves for superheated steam up to 400 lb. pressure and a temperature of 750 deg. F., but have as yet been unable to complete the assignment, pending advice from the Committee on Specifications for Materials as to the proper materials to be used for valves of this character.

Roller Bearings for Locomotive and Tenders

The sub-committee reported in 1939 in detail on general description of methods and practices in effect relative to mounting, dismounting, inspecting, replacing, reconditioning, cleaning, lubricating, etc., of roller bearings, together with statement giving location of roller bearings on which the member roads have been reporting December 1, 1935, to June 1, 1938.

The statement in Table III has been revised including all applications up to December 1, 1939.

The sub-committee was instructed to obtain further experience of roads with regard to roller bearings and their effects upon other parts of locomotives, also develop further information as to economies of such bearing as compared with friction bearings.

Questionnaires were issued by the secretary requesting detailed information and experience of driving box, engine truck, trailer truck, tender truck, side and main rod, valve gear and miscellaneous application of roller bearings as of December 1, 1939.

[The report includes detailed tabulations of roller bearing applications on engine, truck, driving, trailing truck and tender axles, on side and main rods, and valve gears. The tabulations show the number of applications, total mileages made, nature and number of bearing failures and the mileages made per bearing failure.—EDITOR]

Relative to the guarantee of roller bearings as applied to locomotives and tenders, the sub-committee understands that the customary guarantee given by all roller bearing companies is as follows:

0-100,000 miles .....Replace, no charge
101,000-150,000 miles .....Replace 20 per cent of sales price
151,000-200,000 miles .....Replace 40 per cent of sales price
201,000-250,000 miles .....Replace 60 per cent of sales price
251,000-300,000 miles .....Replace 80 per cent of sales price
over 300,000 miles.....Replace 100 per cent of sales price

As to repairing roller bearings found defective—two plans may be followed:

a—Manufacturer to repair parts involved at nominal repair charge and returning bearings for further service with no mileage credit.

b—Manufacturer to repair bearing—no charge. Bearing returned to service with a credit for mileage made to date of removal.

In either case manufacturer to decide whether to repair or to replace bearing.

All failures of roller bearings due to wrecks, or which can be shown to have been caused by neglect on the part of railroad should not be considered part of manufacturers' responsibility.

Relative to inquiry as to hot boxes experienced with roller bearings, only three roads reported hot boxes—three boxes on tenders, and three boxes on locomotives, no data being given as to reason why hot boxes occurred.

As to cost of lubrication per 1,000 miles of roller bearing equipped axles as compared with friction bearings of the same class of locomotives, nearly all roads reported "No record." The cost figures reported by a few roads, we believe, do not indicate a reliable average figure.

One road referred to above is now applying axles made of normalized and tempered manganese vanadium steel of the following chemical properties in per cent:

Carbon	0.27-0.34
Manganese	1.45-1.75
Silicon	Min. 0.15
Phosphorus	Not over 0.045
Sulphur	Not over 0.050
Vanadium	Min. 0.15

(Yield point—70,000 lb. per sq. in.)

The same road is obtaining axles in accordance with A. A. R. Specification M-104-37, Class A, normalized and tempered with roller bearing surfaces cold rolled, one axle being provided with a stress relief groove for test.

One road, reporting no axle failures, uses a low-carbon-nickel steel of the following chemical properties (in per cent) for driving and trailer axles:

Carbon	0.25-0.32
Manganese	0.75-0.95
Phosphorus	0.045
Sulphur	Max. 0.05
Silicon	0.15-0.35
Chromium (max.)	0.15
Nickel	2.50-3.00

One road, reporting no axle failures, uses a carbon vanadium steel.

Shelling of Trailer Wheel Tires

The shelling of trailer tires is now being studied on the six railroads having the greatest amount of trouble.

During the past two years, on these six roads, there has been an increase in the application of heat-treated tires, and the data collected for the period ending October 1, 1939, indicates results have been more satisfactory with heat-treated tires than with non-heat-treated tires.

The sub-committee feels it advisable to continue this study for an additional period, in order to derive the benefit of tests now being made on the above mentioned roads with heat treated tires.

[The report included a tabulation of tire failures reported for a six-month's period ended October 1, 1939.—Editor]

Fusion Welded Locomotive Boiler

At the Mechanical Division conventions held in June, 1937, 1938, and 1939, the Committee on Locomotive Construction submitted report on the above subject. Since these reports were submitted we now have advice that the second semi-annual inspection in the second year of service was made on November 17, 1939, at Oneonta, New York, of the boiler of D. & H. locomotive No. 1219. At this time the boiler was washed, inspected and hydrostatic test applied. Jacket and lagging was removed to inspect the welded seams. Hydrostatic test was of 350 pounds pressure and the inspection showed that the welding of the wrapper sheets and the welding of the firebox, after being carefully examined, were found to be in good condition. The locomotive had made 134,000 miles up until that time and to that date there had not been a simmer from any of the welds.

We have a further letter from the superintendent of motive power dated April 5, 1940, in which he states that since his letter of November 22, 1939, no trouble has been experienced from this boiler and that it has not given any trouble since it was first applied to the locomotive and placed in service on September 24, 1937.

The Committee will continue to follow this matter during the period of inspection required by the Federal inspectors who specify that in the first year of service the lagging and jacket is to be removed and the joints examined each three months, in the second year each six months, and yearly thereafter for a period of five years.

Research Program Covering Axles, Crank Pins and Bearings

[The sub-committee's report was in the nature of a summary of a complete report to be sent to the members at a later date. —Editor]

Introduction

The first progress report issued in May, 1938, stated that the Committee proposed to make further study which would be confined to main crank pins only of both failed pins and pins which were found defective upon inspection. This present report is based on the analysis of information submitted in reply to a questionnaire sent to locomotive voting members, asking them to keep a record of main crank pin renewals and failures for the period November 15, 1937, to August 15, 1938.

A total of seventy-eight railroads sent information in reply to the questionnaire, reporting the ownership of 43,468 steam locomotives. A total of 1,695 main crank pins were removed from these locomotives during the above period. Switching locomotives and three-cylinder locomotives are not considered, as it was felt they were not representative of conditions under investigation. Locomotives reported as being in combination freight and passenger service are included in passenger service tabulations. Main crank pins that were stated as being bored for internal lubrication have been classed as hollow pins. Composite pins have been classed as solid pins.

Analysis of Crank Pin Failures

Total number of main crank pin failures—The total number of main crank pin failures on steam locomotives used in freight and passenger service is:

	No. of Failures
Locomotives in freight service	83
Locomotives in passenger service	68
Total for 9 month's period	151

Average mileage before failures of crank pins—The average for each class of service is:

	Mileage
Locomotives in freight service	165,500
Locomotives in passenger service	169,600
Average mileage for all failures	167,000

Location of failure on crank pins—An analysis of the location of failures on main crank pins shows that in both freight and passenger service more failures occurred in the wheel fit than at any other location on the crank pin. The distribution for each class of service is:

	Percentage
Locomotives in freight service	
In wheel fit	41.34
Flush with hub face	32.0
At fillet next to hub	18.66
At side rod journal	4.0
At fillet between main and side rod; main rod journal; and eccentric fit	4.0
Total number of failures of known location on freight locomotives	100.0
Locomotives in passenger service	
In wheel fit	54.10
Flush with hub face	18.03
At fillet next to hub	18.03
At side rod journal	6.56
At eccentric fit	3.28
Total number of failures of known location on passenger locomotives	100.0

Location of crank pin failures on sides of locomotives—More crank pin failures occurred on the left than on the right side of locomotives, although in the case of passenger locomotives for the period covered by questionnaire failures of main crank pins were evenly divided between the right and left side of the locomotives. Ratio of number of failures on left side and number on right side is:

Freight locomotives	1.31
Passenger locomotives	1.00
Total combined freight and passenger	1.16

Causes of crank pin failures—As in a previous report, the number of failures for which the railroads reported "unknown causes" or "progressive fracture" without giving a cause for these progressive fractures have been grouped together. The main causes for the failures in the different locations are as follows:

a. The cause of 68.75 per cent of the failures in the wheel fit are reported as unknown.

b. The cause of 65.71 per cent of the failures flush with hub face are reported as unknown.

c. The cause of 36.0 per cent of the failures at the fillet next to the hub were reported as unknown.

d. The cause of 85.72 per cent of the failures in side rod journal were reported as unknown.

e. Poor machining was reported as the cause of 60.0 per cent of the failures at fillet between main and side rod, main rod journal and eccentric fit.

Types of locomotives on which failures occurred—Main crank pin failures are classified by types and the analysis indicates that:

1—In freight service in proportion to the number of locomotives in service, more failures of main crank pins occurred on the 4-8-4 type, although the greatest number of actual crank pin failures occurred on the 2-8-2 type.

2—In passenger service the situation is somewhat confused, owing to the number of locomotives that are commonly classified as a freight type locomotive being included in the passenger classification owing to the fact, as stated in the introduction, that where locomotives were reported as being in both freight and passenger service they were classed as passenger. In proportion to the number of locomotives in service the highest ratio of failures on the types that might be classed as commonly used in passenger service occurred on the 4-8-4 type locomotives, while the greatest actual number of failures occurred on the 4-6-2 type locomotives.

Stresses in failed crank pins—Fibre stresses for different crank pin materials and different locations classed by locomotive types and by service are given in four tables. The stresses were computed according to A. A. R. recommended practice. The maximum fibre stress recommended by the A. A. R. is 16,000 lb. per sq. in., and the tables show that the stress in 42.4 per cent of the total number of crank pin failures was above this limit. The stress in 27.2 per cent of the total number of main crank pins that failed was found to be in the range between 15,000 and 16,000 lb. per sq. in.

Analysis of Crank Pin Removals

Average mileage before renewal of main crank pins—The average mileage before renewal of main crank pins for causes other than failure is as follows:

Class of Service	Average Mileage When Removed: Found Cracked On Inspection	Reached Wear Limit	Reached Mileage Limit
Freight	104,500	144,300	164,000
Passenger	116,900	174,000	164,000

These results seem inconsistent in the case of freight locomotives with respect to the mileage attained on pins removed on account of reaching the wear limit and mileage limit. This inconsistency is due to the fact that service conditions undoubtedly influenced the results more in the case of freight locomotives. For example, on the 4-8-4 type locomotives 25 pins were shown to have been removed on account of reaching the wear limit with an average mileage of 127,900 miles, while 22 pins were shown to have been removed on account of reaching the mileage limit with an average mileage of 250,400 miles.

Total number of crank pin renewals—The total number of main crank pin renewals for causes other than failures on steam locomotives used in freight service is as follows:

	No. of main crank pins renewed
Locomotives in freight service	827
Locomotives in passenger service	744
Total for 9 months' period	1571

Cause of crank pin renewals—A summary of the causes of main crank pin renewals, for causes other than failures, on steam locomotives used in freight and passenger service is as follows:

Class of Service	Found cracked on inspection	Per cent of total	Reached wear limit	Per cent of total	Reached mileage limit	Per cent of total	Total
Freight	34	4.1	605	73.2	188	22.7	827
Passenger	137	18.4	347	46.7	260	34.9	744
Total	171	10.9	952	60.5	448	28.6	1571

Types of locomotives on which pins were renewed on account of being cracked—The analysis of main crank pins found cracked on inspection indicates that:

1—In freight service in proportion to the number of locomotives in service, more cracked pins occurred on the 4-8-4 type, although the greatest number of cracked pins were found on the 2-10-2 type.

2—In passenger service in proportion to the number of locomotives in service, more cracked pins occurred on the 4-6-4 type, although the greatest number of cracked pins were found on the 4-6-2 type.

Stresses in crank pins removed for causes other than failure—Fibre stresses for different crank pin materials and different types of locomotives used in freight and passenger service are given in two tables. The stresses were computed according to A. A. R. recommended practice. The maximum fibre stress recommended by the A. A. R. is 16,000 lb. per sq. in., and the above tables show that the stress in 43.1 per cent of the total number of main crank pins removed was above this limit. The stress in 19.7 per cent of the total number of main crank pins removed was in the range between 15,000 and 16,000 lb. per sq. in.

Combined Analysis of Main Crank Pins That Failed in Service or Were Removed for Other Causes

Average mileage—The average mileage of all pins removed is shown in a table which indicates that the general average for main crank pins in freight service is 148,600 miles, and in passenger service 161,100 miles. This is less than the average of failed crank pins due to the low average mileage of 104,500 in freight service and 116,900 in passenger service of main crank pins found cracked on inspection.

Total number of main crank pin renewals—The summary of main crank pin renewals is as follows:

	No. of main pins renewed
Locomotives used in freight service	896
Locomotives used in passenger service	799
Total for 9 months' period	1695

Cause of main crank pin renewals—A summary of the cause of renewal of all main crank pins in both freight and passenger service is as follows:

Class of Service	Failed	Per cent of total	Found cracked on inspection	Per cent of total	Reached wear limit	Per cent of total	Reached mileage limit	Per cent of total	Total
Freight	69	7.7	34	3.8	605	67.6	188	20.9	896
Passenger	55	6.9	137	17.2	347	43.4	260	32.5	799
Total	124	7.3	171	10.1	952	56.2	448	26.4	1695

Crank pin materials—The material and average mileage obtained at renewal for different materials where same could be definitely determined, classified by cause for renewals is shown in two tables. This is shown as a matter of information, as it is felt the data is insufficient to permit of drawing any conclusions.

Types of locomotives on which main crank pins were renewed

on account of having failed or being found cracked—This information is shown classified by types of freight locomotives in two tables which indicate the number of locomotives of various types in service as of September 1, 1938, and that:

1. In freight service, in proportion to the number of locomotives in service, more renewals on account of failed or cracked pins occurred on the 4-8-4 type, although the greatest number of renewals occurred on the 2-8-2 type, closely followed by the 2-10-2 type.

2. In passenger service, in proportion to the number of locomotives in service, more renewals on account of failed or cracked pins occurred on the 4-6-4 type, although the greatest number of renewals occurred on the 4-6-2 type.

General Conclusions

All indications point unmistakably to the fact that main crank pin failures are relatively more frequent, both in freight and passenger service, on modern engines capable of exerting high horsepower at high sustained speeds. This can readily be seen from a study of the data which indicates that for any driving wheel arrangement, as the number of trailing wheels increase, necessitated by the increased firebox and boiler capacity, the ratio of failed and cracked pins to the number of locomotives in service increases. Inasmuch as the data also points to the desirability of holding the fibre stress below 15,000 lb. per sq. in., the logical conclusion is that to reduce the possibility of main crank pin failures in locomotives designed for high horsepower outputs at sustained high speed, the total piston thrust should be divided over two driving units.

This, however, does not help the situation with respect to the many locomotives now in service, and which will be continued in service for some time to come. The situation is not critical as evidenced by the fact that on a yearly basis the number of main crank pins that fail in service is only two tenths of one per cent of the number of main crank pins in service, and the yearly cost of replacing main crank pins that fail in service or are found cracked on inspection amounts to approximately $30,000. However, the failure of a main crank pin on a locomotive at high speed will cause damage out of all proportion to the actual cost of replacing a crank pin, so that anything that can be done to prevent such failures is well worthwhile.

Proper machining is one remedy that is directly in the control of the individual road. Poor machining is indicated as the cause of 23.54 per cent of all main crank pin failures, so that considerable improvement can be attained through careful attention to proper machining. The importance of proper machining increases as the severity of service conditions increases so that on the modern types of power used under severe service conditions proper machining is paramount.

Next to proper machining probably the most feasible action that can be taken is to set up proper mileage limitations, depending on the type of locomotive and conditions of service. This cannot be set up on an average basis for all railroads, but must be done by each road for itself, adjusting the limitations set up in accordance with the ratio of the actual service conditions under which the locomotives are being used as compared to the general average. It is felt that the information contained in the analysis in this report will be helpful to roads desiring to set up such limitations.

As indicated before, it seems apparent that to materially increase the average life of main crank pins before failure it is necessary to considerably reduce the stress or find some means of improving the life expectancy under the present stresses. On existing engines, it is out of the question to reduce the stress, and on many new locomotives it will be found impossible due to limitations imposed in design on account of the axle diameter and stroke to secure a main crank pin with a fibre stress below 15,000 lb. per sq. in. Therefore, if means can be found to increase the life expectancy of the pin under the higher stresses it is important. From other investigations that have been conducted in somewhat analogous problems the committee is aware of two procedures that offer possibilities. These are: (a) Cold rolling the wheel fit of the crank pin; (b) Flame hardening the wheel fit of the crank pin.

These are definitely experimental, but the committee feels that with the issuance of this report all has been accomplished that can be accomplished by statistical studies, and these studies point to the need of some means of increasing the life expectancy of main crank pins. It is believed that this is a proper subject for A. A. R. experimental work, and it is recommended that consideration be given to granting an allowance for such work along these lines next year.

Tolerance for Cotter Keys

Conditions as regards variation in diameter of cotter keys as made by manufacturers, we find are substantially as reported by a member road. Further, we find that the various locomotive builders and railroads have no regular standards for the ordering of cotter keys but place orders as required with the different manufacturers of cotters, ordering same to the diameter of the drilled hole for the cotter.

We have canvassed the various cotter manufacturers, suggesting that an attempt be made to maintain a tolerance of nominal diameter —.005 inch, with the following results.

(1) To produce cotters to closer tolerances than present commercial standards does not appear attractive to the cotter manufacturers and they showed only meager evidence of a desire to cooperate in this direction.

(2) They pointed out that the cotters being made from wire are subject to two tolerances—one, the tolerance allowed on the wire size itself and the other, the tolerance allowed in the formation of the cotter.

(3) If a tolerance of nominal diameter —.005 inch is our aim, they would insist on a range from —.005 inch to —.010 inch under the nominal diameter.

(4) These would be special for railroad work and would not be carried in stock, necessitating the manufacture in relatively small quantities of cotters in the various sizes.

(5) Existing sizes conform to Government standards, Navy Department standards, Automobile manufacturers, and many others.

(6) When made to a tolerance of —.005 inch to —.010 inch under nominal size, the cost would be approximately 50 per cent more than the sizes now furnished in quantities of 100,000 and with smaller quantities the cost would be still further increased.

Conclusions—Inasmuch as cotters as now furnished are satisfactory for all other kinds of machinery and for many locations in locomotive construction, it would be the recommendation of this Committee that no change be made in existing standards, but where a tighter fitting cotter is desired, some form of expanding cotter be used.

The report included a statement covering tolerances secured from five different cotter manufacturers and reported by one railroad; also a summary of these various tolerances.

Locomotive Boiler and Firebox Materials and Construction

While there are numerous types of boilers and fireboxes in use, some of which are of special construction, the great majority of locomotive boilers in use on the various American railroads are of the conventional type. Therefore the committee will undertake first to determine the best solution to some of the problems encountered in the design and maintenance of large locomotive boilers of the conventional fire tube wide firebox type.

During the past decade the principal trend has been to increase capacity, efficiency and reliability of locomotive boilers and at the same time reduce the cost of maintenance.

Capacity, other things being equal, is controlled or limited by boiler diameter. Therefore it appears this is a logical basis for comparison and proportion.

Boiler diameter controls capacity, primarily due to its control of the gas area of the flues which is confined within close limits if other desirable proportions are not encroached upon, such as: Distance between crown sheet and roof sheet which controls steam disengaging surface and steam space; Distance between combustion chamber and shell at bottom and sides; minimum allowable space between flues and firebox side and crown sheets to provide for suitable flange radius to provide flexibility and prevent excessive maintenance due to sheets cracking; width of water space at mud ring on sides and rate of increase in water space from mud ring to crown sheet radius; and, distance or space between flues to provide adequate circulation for maximum efficiency and prevent cracking of tube sheets between tubes.

Other proportions which control efficiency of operation and cost of repairs are ratio of length of combustion space to flue length and ratio of flue length to flue diameter.

The firebox capacity is controlled by clearance and weight limitations only. The size of grate area should be in proportion to the maximum output expected of the boiler and the quality of the coal to be burned.

The question of the percentage of air openings through the grates and the manner of admission of air, in addition to influencing capacity and economy, may be such as to have detrimental effects on firebox sheets and staybolts.

The committee will proceed first with the further study of general structural conditions in locomotive fireboxes. A questionnaire has been prepared and has been sent out to various railroads and locomotive builders in order to obtain the latest practice, data and formulae for the benefit of the Committee in its study.

The following is a resume of an investigation made by the Denver & Rio Grande Western as to locomotive boiler back end movement under hydrostatic pressures. The Report was dated April, 1940:

"An investigation was made to determine the movement of the component parts of the back end of a locomotive boiler (4-6-6-4 type) under hydrostatic pressures. The locomotive in question having inside dimensions of firebox as follows: Length 182 inches, width 104¼ inches. The length of firebox measured from back flue sheet to firebox door sheet is 28 feet 2 inches. Two syphons are installed in the firebox and one in the combustion chamber.

"Measurements of the movements were taken at 206 points on the back end of boiler, including inside of firebox and combustion chamber. Seven tests were made under the following conditions:

Boiler empty,
Boiler filled with water, no pressure.
Boiler under 100 lb. hydrostatic pressure.
Boiler under 200 lb. hydrostatic pressure.
Boiler under 255 lb. hydrostatic pressure.
Boiler under 319 lb. hydrostatic pressure.

The above tests had a water temperature of about 100 deg. F., and the seventh test was taken with 255 lb. hydrostatic pressure with a water temperature of 210 deg. F. The outside temperature under all tests was approximately 68 deg. F. A total of 1,418 readings were taken.

In general it was found that the top sags down and the sides spread out.

The maximum downward movement was 7/16 inch for the roof sheet and 31/64 inch (or nearly ½ inch) for the crown sheet. The maximum spread (both sides together) was 43/64 inch (or nearly 11/16 inch) for the roof sheet and 35/64 inch (or nearly 9/16 inch) for the crown sheet. Maximum downward movement is ¼ inch for the syphons. Maximum spread of the mud ring was 3/32 inch. Maximum spread between the syphons was 11/16 inch. Maximum longitudinal movement was 19/64 inch (or nearly 5/16 inch) at 210 deg. temperature.

It developed that the downward movement in the vertical direction is smaller at 210 deg. F. temperature than at 100 deg. F., and the lateral spread is greater at 210 deg. F. than at 100 deg. F. temperature.

These movements indicate that the back end of a boiler is continually moving up and down in the vertical direction and in and out in the lateral direction whenever there are changes in pressures and temperatures. Therefore, the back end of a boiler must be of substantial construction in order to keep movement down to a practicable minimum. Roof sheet thickness should be developed to meet deflection requirements as well as strength requirements.

Other Items

Progress was reported by sub-committees on locomotive guiding, spring suspension and rail stresses; stresses in rods and motion work, and standardization of wrought steel wheels for Diesel locomotives and steam locomotive tenders.

The report was signed by H. H. Lanning (chairman), mechanical engineer, A. T. & S. F.; H. P. Allstrand (vice-chairman), assistant to chief executive officer, C. & N. W.; E. L. Bachman, general superintendent motive power, Pennsylvania; F. E. Russell, mechanical engineer, Southern Pacific; W. F. Connal, chief mechanical engineer, C. N. R.; J. E. Ennis, engineering assistant, N. Y. C.; J. B. Blackburn, mechanical engineer, C. & O.; L. H. Kueck, chief mechanical engineer, Mo. Pac.; W. H. Sagstetter, chief mechanical officer, D. & R. G. W., and K. Cartwright, mechanical engineer, N. Y. N. H. & H.

Discussion

D. Sheehan, superintendent motive power, C. & E. I., in commenting on the report of the sub-committee on wheel centers within thin walls sections said that he had found nine roads reporting in 1939 which are not mentioned in the 1940 report. This, he said, tended to reduce the value of the report through lack of cooperation of these roads with the committee. While the proportion of defects which have developed is not large, he said, the trend seems to be toward more failures and the character of the failures indicated the need for continuing the study.

H. W. Faus, engineer motive power, was inclined to question the conclusions of the subcommittee reporting on the Research Program Covering Axles, Crank Pins and Bearings, since the causes of failures were unknown in more than 64 per cent of the cases reported. He cited the experience of the New York Central in support of the statement that poor machine work was not an important factor in failures of these parts on that road during the past thirteen years. He referred to 32 failures of crank pins in the eccentric-crank keyways during 1928, 1929 on Classes Jla, b and c. The valve travel was reduced to 8½ in. and another keyway added. For the next two years there were no further failures. Crank-pin failures in the wheel-seat fillet were ended by a change from carbon steel to carbon-vanadium steel. Two older lots of locomotives of another class on which there were no crank-pin failures were followed by 104 failures in two years on two later lots of the same class. These crank pins were of carbon-vanadium steel with ¼-in. wheel-seat fillets. Investigation disclosed a change in heat treatment involving a lower normalizing and higher drawing temperature than previously employed. All but one of the failures were traced to this cause. At a later date failures in the eccentric-crank keyways again appeared. In this instance a change in the bolting to hold the eccentric crank more rigidly on the pin ended the difficulty. Another mild epidemic of failures through the wheel seat was also traced to the heat treatment.

While not considering poor machine work a factor in the failures experienced by the New York Central, Mr. Faus agreed with the committee that it could not be tolerated. He did not feel that the experience on the New York Central would justify the establishment of a definite mileage life for crank-pin service.

In commenting on the recommendation of the committee's suggestion of the desirability of holding the fibre stress in crank pins below 15,000 lb. per sq. in., Mr. Faus said that the design stresses in the crank pins of three classes of New York Central locomotives were as follows: J1, 18,350 lb.; J3, 19,030 lb.; L2, 19,200 lb.

The report was accepted and referred to letter ballot.

Report on Car Construction

In the report for last year we stated that the full Car Construction Committee, in cooperation with the Freight-Car Design Committee of the American Railway Car Institute, had undertaken an economic study of lightweight box-car designs in line with program of 1932, items (a) to (f) inclusive, Appendix A to Circular No. D. V.—768 for that year. Further, that tentative designs for the following types of construction had been submitted for study and analysis: Lightened design in carbon-steel riveted construction; combination of carbon-steel riveted and welded construction; alloy steel with combination of welding and riveting; alloy steel, largely of welded construction.

This part of the work has been completed and last December your committee submitted to the A. R. C. I. a detailed comparative tabulation of design characteristics, weights and other data for the above types of construction and the A. A. R. standard steel-sheathed large size box car of 1937 of carbon-steel riveted design. This tabulation of characteristics was based largely on the designs tentatively proposed by the A. R. C. I. who were advised that your committee would be glad to have this undertaking progressed on the following basis:

(1) Prepare a design (or designs) of an improved steel-sheathed box car which the A. R. C. I. Committee would recommend for quantity construction as might be required.

(2) Strength, with corresponding anticipated service life, to be

Table I—New Cars Ordered May 1, 1939 to May 1, 1940

Item		Number of cars
	BOX AND AUTO BOX	
1.	A. A. R. throughout	
	(a) A. A. R. Standard; height 10 ft.; width 9 ft. 2 in.; length 40 ft. 6 in.	4,917
	(b) A. A. R. Standard; height 9 ft. 4 in.; width 8 ft. 9⅛ in.; length 40 ft. 6 in.	375
2.	A. A. R. throughout except light weight	
	(a) Height 8 ft. 6⅝ in.; width 9 ft. 2 in.; length 40 ft. 6 in.	100
	*(b) Height 10 ft.; width 9 ft. 2 in.; length 40 ft 6 in.	5,400
3.	A. A. R. throughout except light weight and to larger clear dimensions	
	(a) Height 10 ft. 5 in.; width 9 ft. 2 in.; length 50 ft. 6 in.	300
	(b) Height 10 ft. 6 in.; width 9 ft. 2 in.; length 40 ft. 6 in.	2,000
	(c) Height 10 ft. 6 1/16 in.; width 9 ft. 4¼ in.; length 50 ft. 7 15/16 in.	50
4.	A. A. R. but to larger clear dimensions	
	(a) Height 10 ft.; width 9 ft. 1½ in.; length 50 ft. 6 in.	350
	(b) Height 10 ft. 1 13/32 in.; width 9 ft. 2 in.; length 50 ft.	100
	(c) Height 10 ft. 4⅞ in.; width 9 ft. 2 in.; length 40 ft. 6 in.	1,000
	(d) Height 10 ft. 6 in.; width 9 ft. 2 in.; length 50 ft. 6 in.	1,700
	(e) Height 10 ft. 5 5/16 in.; width 9 ft. 2 in.; length 40 ft. 4 5/16 in.	100
	(f) Height 10 ft. 1⅞ in.; width 9 ft. 2 in.; length 40 ft. 6 in.	2,765
5.	A. A. R. design throughout except floating center sills	
	(a) Height 9 ft. 4 in.; width 8 ft. 9⅛ in.; length 40 ft. 6 in.	500
	(b) Height 10 ft.; width 9 ft. 2 in.; length 40 ft. 6 in.	600
6.	A. A. R. design throughout except floating center sills and to larger clear dimensions	
	(a) Height 10 ft. 4 in.; width 9 ft. 2 in.; length 40 ft. 6 in.	1,800
	(b) Height 10 ft. 4 in.; width 9 ft. 2 in.; length 50 ft. 6 in.	200
7.	A. A. R. design throughout except center plate height 26¾ in., and to larger clear dimensions (A. A. R. relation between line of draft and neutral axis of center sill maintained).	
	(a) Height 10 ft. 4 in.; width 9 ft. 2 in.; length 40 ft. 6 in.	2,000
	(b) Height 10 ft. 4 in.; width 9 ft. 2 in.; length 50 ft 6 in.	500
8.	A. A. R. design throughout except light weight and floating center sills, and to larger clear dimensions	
	(a) Height 10 ft. 4⅛ in.; width 9 ft. 2 in.; length 40 ft. 6 in.	400
	(b) Height 10 ft. 8⅛ in.; width 9 ft. 2 in.; length 40 ft. 6 in.	100
9.	Not A. A. R. design but 25¾ in. truck height	149
10.	Not A. A. R. design	4
	Total	25,410

* Including 500 special welded cars.

	HOPPER CARS 50 TONS NOMINAL CAPACITY	
11.	A. A. R. Standard throughout	5,415
12.	A. A. R. design throughout except light weight and changes in inside dimensions to meet specific conditions	1,500
13.	A. A. R. Standard except changes in inside dimensions to meet specific conditions	10,250
14.	A. A. R. design throughout except floating center sills	1,000
15.	A. A. R. design throughout except floating center sills and changes in inside dimensions to meet specific conditions	500
16.	Not A. A. R. design except center sill section and 25¾ in. truck height	1,000
17.	Not A. A. R. design except 25¾ in. truck height	1
	Total	19,666
	HOPPER CARS 70 TONS NOMINAL CAPACITY	
18.	A. A. R. Standard throughout	100
19.	A. A. R. design throughout except light weight	1,000
20.	A. A. R. Standard except changes in inside dimensions to meet specific conditions	160
21.	A. A. R. Standard except light weight and change in inside dimensions to meet specific conditions	100
22.	Not A. A. R. design. 26¾ in. truck height. Light weight	500
	Total	1,860
	FREIGHT REFRIGERATOR CARS	
23.	A. A. R. Standard	100
24.	A. A. R. Standard except inside dimensions Width 8 ft. 4⅜ in.; length 32 ft. 9⅜ in.	250
25.	A. A. R. Standard except inside dimensions Height 6 ft. 8 in.; width 8 ft. 3 in.; length 39 ft. 4 in. top bunkers	200
26.	A. A. R. Standard except floating center sills	300
27.	Not A. A. R. Standard. Super Giant Height 7 ft. 7½ in.; width 8 ft. 8 in.; length 42 ft. 6 in.; 26¾ in. truck height	20
28.	Not A. A. R. Standard. Super Giant Height 6 ft. 6 in.; width 8 ft. 8 in.; length 50 ft. 1 in. 26¾ in. truck height. Top bunkers	5
29.	Not A. A. R. Standard. Giant Height 6 ft. 9½ in.; width 8 ft. 8 in.; length 50 ft. 25¼ in. truck height. Top bunkers	10
30.	Not A. A. R. Standard. 50 ton with floating center sills Height 7 ft. 9 1/16 in.; width 9 ft. 1½ in.; length 42 ft. 1¾ in.	100
31.	Not A. A. R. Standard. 50 ton with floating center sills Height 7 ft. 6 1/16 in.; width 8 ft. 11 in.; length 42 ft. 1¾ in.; Super-insulated	50
32.	Wood sheathed Class B construction for meat service. A. A. R. Standard center sills. 25¾ in. truck height	350
33.	"RB" 40-ton cars for beer service. A. A. R. Standard center sills. 25¾ in. truck height	25
	Total	1,410

equivalent to that of the present A. A. R. standard car of enlarged dimensions as submitted in 1937, Appendix A to Circular DV-920.

(3) General dimensions to be same as for car under Item (2).

(4) The base design (or designs) to have doors and fixtures, roofs and ends of types as shown on Plate 1500, Appendix A to A. A. R. Circular DV-920, but of the latest designs. If desired, alternate design (or designs) may be submitted with these features similar in type to those illustrated on Plate 1501 of that Appendix.

(5) A more substantial floor structure than now shown by the present standard car drawings should be provided.

(6) Corner-post construction for the base design should be in accordance with an improved arrangement for which sketch was submitted.

At the time of our final meeting last March, this work had not advanced far enough for further joint conference, but it was then planned to call a special meeting of both committees previous to the annual meeting if progress made should warrant such action, in which case a supplementary statement would be prepared by the chairman for inclusion in the proceedings of the Mechanical Division for this year.

Welded Hopper Cars

When submitting to the A. R. C. I. the above proposed steel sheathed box-car development program, your committee also requested the preparation of tentative designs of welded and riveted 50 and 70 tons' nominal capacity hopper cars, which the car institute would be in position to recommend for quantity production as required, it being the belief of your committee that such construction, either in high-tensile low-alloy or plain carbon steel, should provide the benefits of longer anticipated useful service life account elimination of rivet holes and corrosion in lap joints and other connections present in cars of riveted construction; also that some weight reduction should be obtained.

It was proposed to the car institute that the designs shown in Appendix A, Circular DV-836, report of Committee on Car Construction dated June, 1935, should form the basis for this work.

For both capacities of cars, over-all width and height of sides from top of rail, as indicated on these drawings, should be followed. Rail load limit capacity should be obtained with lading at 52 lb. per cu. ft. including 10-in. average heap, same as for the carbon-steel riveted designs.

The status of this work and subsequent procedure is the same as described above for the improved designs of steel-sheathed box cars.

Table II—New House Type and Hopper Cars Ordered May 1, 1939 to May 1, 1940*

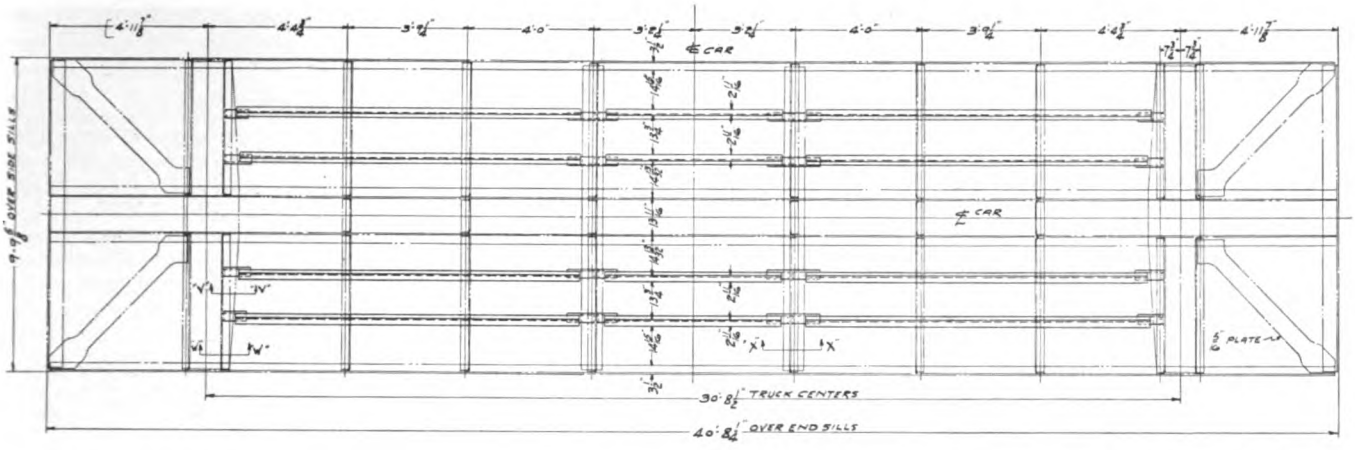
Item	Design	No. of cars	Per cent of total
34.	A. A. R. throughout or conforming thereto including light weight alloy steel to A. A. R. base dimensions, floating center sills, and inside dimensions to meet specific conditions	42,782	91.15
35.	A. A. R. except 26¾ in. center plate height	2,500	5.33
36.	Not A. A. R. except center sills and 25¾ in. truck height	1,000	2.13
37.	Not A. A. R. design except 25¾ in. truck height	150	.32
38.	Not A. A. R. design	504	1.07
	Total	46,936	100.00

* This is a condensed compilation of cars reported in Table No. 1 except the refrigerator cars referred to in items (23) to (33) inclusive.

Freight Cars Ordered May 1, 1939, to May 1, 1940

The 1936 report of your committee presented the question of whether or not the majority of member roads desired the continuation of the work on A. A. R. design cars. The matter was discussed on the floor of the convention. Since that time your committee has set forth in each annual report a statement of the freight cars ordered during the preceding year with sufficient characteristics of design to indicate the extent to which the member roads were following freight car A. A. R. standardization.

[At this point in the report, the committee inserted detailed tables showing a total of 46,936 new house-type and hopper cars ordered during the period of May 1, 1939, to May 1, 1940, of which 42,782 cars, or slightly over 91 per cent, were designed to



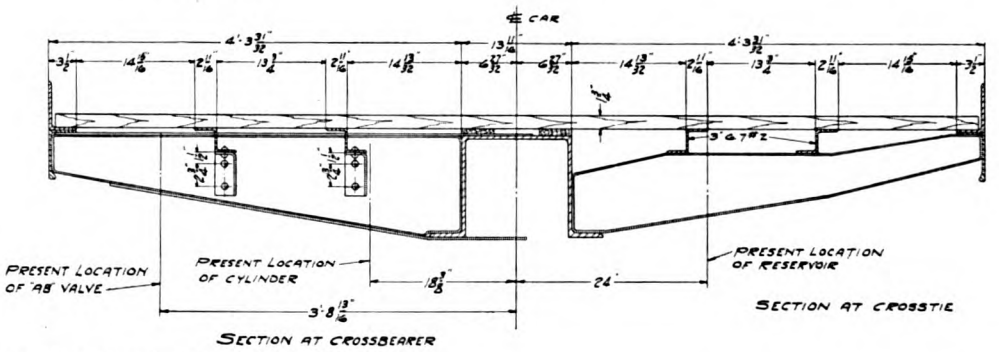


Fig. 1—Application of stringers to strengthen floor construction of A. A. R. box cars of cars used in general service — The weights and sizes of the materials in the proposed arrangement are shown in the table at the bottom of this page

"A. A. R. specifications throughout, or conforming thereto, including lightweight alloy steel to A. A. R. base dimensions, floating center sills, and inside dimensions to meet specific conditions." Of the remaining cars, 2,500 were A. A. R. design except for center-plate height; 1,150 cars conformed to A. A. R. design only in such details as center sills or center-plate height; 504 cars or 1.07 per cent were non-A. A. R. design.]

No standard A. A. R. designs of gondola, flat, stock, ballast and special type cars have been developed, and 10,036 cars of these various types were ordered in the period of May 1, 1939 to May 1, 1940. With 1,410 refrigerator cars, this makes a total of 58,382 cars, ordered in the period mentioned, of which 53,384, or 91.44 per cent have standard 25¾-in. center-plate height; 3,229 have 26 ¾-in. center-plate height; 20 have 26 ⅜-in. center-plate height; 1,700 have 26⅛-in. center-plate height; and 49 have 26-in. center-plate height.

[Table I includes the box, auto box, hopper and refrigerator cars and Table II gives a summary of the information in Table I. A third table, including gondola, flat, stock, ballast and special

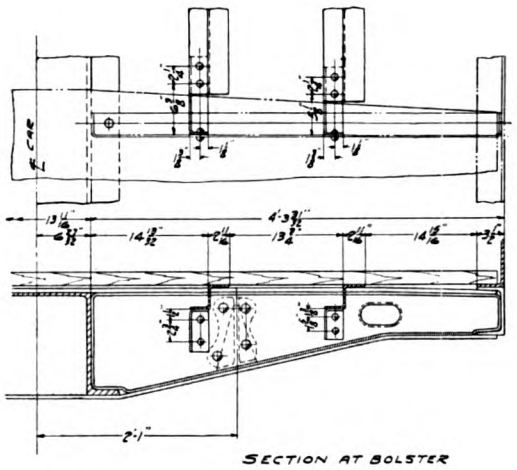


Table III—Proposed Arrangement—Weight of Floor Supports and Connections

No. per Car	Description	Material	Weight each, lb. per ft.	Total weight, lb. per ft.
4	Floor support, bolster and crossbearer	3 in. 6.7 lb. per ft. Z-bar x 10 ft.-11¾ in.	73.56	294.24
4	Floor support, bolster and crossbearer	3 in. 6.7 lb. per ft. Z-bar x 10 ft.-10¾ in.	73.0	292.0
4	Floor support between crossbearers	3 in. 6.7 lb. per ft. Z-bar x 5 ft.-7¾ in.	37.827	151.31
4	Floor support connection (section W-W)	6⅛ in. x ¼ in. x 10¾ in.	3.92	15.69
12	Floor support connection (section V-V & X-X)	7⅝ in. x ¼ in. x 12 in.	5.1	61.2
8	Floor support connection (section X-X)	7⅝ in. x ¼ in. x 9½ in.	4.0	32.0
4	Diagonal brace	10 in. x 5/16 in. x 5 ft. 9 in.	57.97	231.88
80	Rivets	⅝ in. diameter x 1⅞ in. long	....	20.8
16	Rivets	⅝ in. diameter x 2⅛ in. long	....	4.48
136	Floor bolt with one nut	½ in. diameter x 2¾ in. long	....	30.14
		Total weight		1133.74

type cars appeared in the report; this is not reproduced here.—EDITOR]

Box-Car Floors

The question of damage to box-car floors due to heavy concentrated loads imposed by power trucks when handling steel sheets, ingots, bars and similar lading, was referred to in the report for last year.

It has been decided in view of the information available and experience of certain roads that suitable designs of strengthened floor construction could be developed to cover the situation without conducting special loading tests and general drawings have been prepared to show the strengthened construction.

The construction for general service, as shown in Fig. 1, consists essentially of two 3-in. 6.7-lb. Z-stringers located on each side of the center sill. The diagonal braces have been increased in thickness from ¼ in. to 5/16 in.

Alternate construction where a still stronger floor construction is considered necessary or desirable by individual railroads, consists essentially of two 4-in. 8.2-lb. Z-stringers located on each side of the center sill with diagonal braces increased in thickness from ¼ in. to 5/16 in.

[A drawing, (not included in the present abstract of the subcommittee report) showed the alternate construction in detail and included a table of comparative weights and material sizes. It was recommended that these drawings and tables be submitted to letter ballot.—EDITOR]

Changes in Standard Steel-Sheathed Box Car

CORNER CONSTRUCTION

During the past year a study has been made with a view to increasing the strength of the present square corner and Z-bar corner post construction as shown on Plates 504-B and 1504, Supplement to the Manual for the A. A. R. base designs of steel-sheathed box cars.

To provide added strength against tendency of ends to bend outward with shifting loads, a number of roads already have used a rounded corner construction with a W-section corner post as shown in one of the drawings which accompanies this report. This represents a much more substantial arrangement with only a slight increase in weight as compared with the present square corner and Z-bar corner post.

It is the recommendation of your committee that the arrangement (Fig. 2) be submitted to letter ballot for adoption and if approved, the drawings in the Supplement to the Manual will be changed accordingly for base cars shown on Plates 500-B and 1500-A respectively.

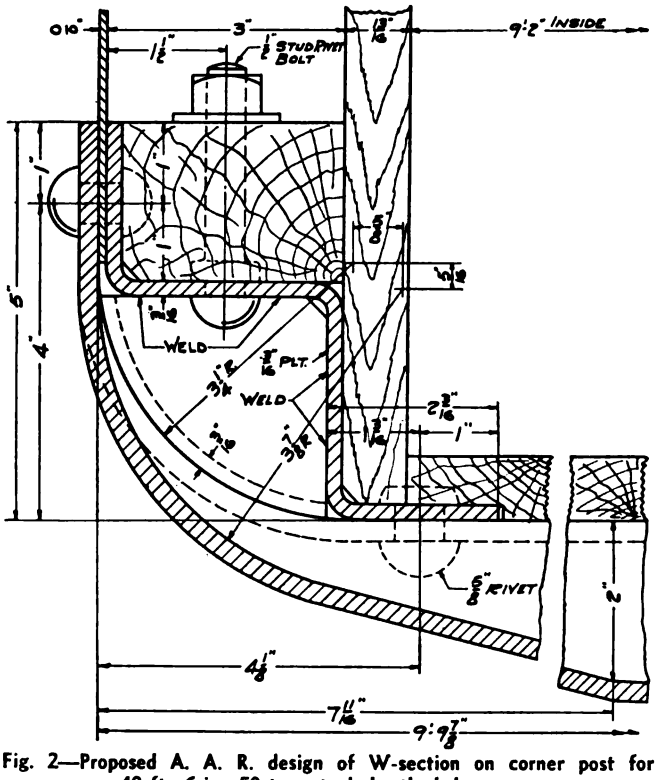


Fig. 2—Proposed A. A. R. design of W-section on corner post for 40-ft. 6-in. 50-ton steel-sheathed box cars

ROOF CONSTRUCTION

In view of the more general use of an improved solid-steel roof construction, your committee recommends incorporation in the base designs of a solid steel roof intended for future applications in place of the designs on Plates 502-B and 1502.

The following table shows a comparison of the present and proposed base designs. The comparative weight figures shown, apply only to the roof for the 9-ft. 2-in. wide car, as covered by Plate 1502:

Comparison of Present and Proposed Base Roof Designs

	Present design plate No. 1502	Proposed design
Gage of roof sheets	No. 15	No. 15
Thickness of seam caps, in.	5/32	¼
Height of seam caps, in.	3 3/16	2¼
Complete weight per car, lb.	1,858	1,694
Saving in weight per car, lb.	....	164

Roofs of the proposed design are already in service on thousands of cars and it is believed with the better balanced low cap construction, a design will be provided which permits the entire roof to work as a unit while with the former high cap design there was a tendency for the caps to take the load before the sheet panels came into play.

The committee recommends that the roof arrangement shown as Sketch No. 4 in the report be submitted to letter ballot for adoption. If approved, the drawings in Supplement to the Manual will be changed accordingly for base cars now shown by Plates 500 and 1500.

End Lining for Box Cars

Present end lining installation for the standard box cars consists of 13/16-in. tongue and groove vertical lining boards resting directly against the corrugated-steel end and secured by nailing to horizontal wood furring strips located in corrugations and held by stud bolts. The end floor board is rabetted to receive lower ends of end lining boards and short Z-shaped metal clips are provided for holding the top of lining boards adjacent to the sides of the car.

Exceptions have been taken to this application, particularly by grain and flour shippers who have maintained that lading becomes lodged in corrugations back of end lining boards resulting in shortage, and where not removed affords breeding place for vermin. Further, that to recover lading which may become trapped in this manner usually necessitates the removal and replacement of large sections of the end lining.

Of the various alternate schemes which have been proposed from time to time, the arrangement which has been most frequently suggested by the shippers consists of applying end lining boards horizontally, secured to vertical furring strips attached to the steel end and having opening with bevel strip at bottom for self-clearing and to permit blowing out when necessary, similar to side lining application. This change in the application of end lining is not considered desirable, mainly because lining boards would be exposed to breakage by being unsupported between furring strips. Furthermore, in order to maintain present inside length of car it would be necessary to increase the overall length an amount equal to thickness of end furring strips and lining boards. To provide strength approaching that of present construction, in which lining boards are supported for the full width of the car, bearing directly against the steel end and with furring strips applied in the corrugations, it would be necessary to closely space the vertical nailing strips and materially increase the thickness of the end lining boards with resultant increase both in weight and cost of construction.

As will be noted by reference to plates 504-B and 1504 of the Supplement to the Manual, wood furring strips extending approximately the full length of the end corrugations are applied in the first three corrugations above the floor line, at center of end and in the top corrugation. If furrings are of sound wood properly attached to the steel end and lining boards are securely nailed thereto, the lining will maintain its position. Examination of a large number of cars has shown that in the majority of cases the end lining follows the steel end when the latter becomes bowed outwardly up to as much as 4 in. at center. If

the tongues and grooves of end lining boards are of correct dimensions and provide proper fit, no leakage of grain should occur, therefore, where end lining is properly applied and maintained free from holes or punctures, no difficulty should be experienced because of leakage of lading through the end lining.

Plates 504-B, 1504 show a Z-bar corner post with furring strip between the post and the steel end, this being the furring to which the side lining is nailed. There is, however, approximately 1 in. space between this furring strip and the steel-end extending from floor to roof. The corrugations in the steel end overlap this open vertical channel so that any grain leakage at the corners would be fed to the corrugations and gradually work its way over to the center of the car. Grain leakage at the corner-post opening may be caused by warpage or improper fastening of side lining to furring, short furring strips not fitted tightly against side plate or sill and poor fit between corner end lining boards and side lining. This particular condition may be corrected to a large extent by increasing the size of the corner-post furring strip to completely fill the space between Z-bar corner post and steel end, or by driving a loose wooden strip in between the furring and the steel end, making sure that this opening is blocked solid from side sill to side plate.

However, a new design of corner post construction, covered elsewhere in this report, will, if adopted, materially improve for new cars, the conditions described in the foregoing paragraphs.

Side Frames and Bolsters

During the past year, numerous new designs of side frames and bolsters were submitted for approval. Some of these new designs have been approved and in some cases the applications are still pending. Nine new side frame designs were approved, eight for 50-ton trucks and one for 70-ton trucks. Among these are various features of double-truss and spring-plankless designs. They also include Barber stabilized and full-cushion trucks. With the exception of two 50-ton and the 70-ton trucks, these were all of Grade B carbon steel; the exceptions are alloy steel.

The approved bolster designs are 15 in number, of which 8 are in alloy steel, 5 are Grade B carbon steel and 2 pressed and welded-rolled-steel designs. Applications are pending on 12 side frame designs and 7 bolster designs.

Report of Sub-Committee on Journal Boxes

To provide improved service performance and assist in preventing uneven wear in the roof of the journal box, it is recommended that the inside contour at the top of journal boxes, A, B, C, D, E, and F, be changed as shown in Fig. 3. This drawing also includes recommended increase in the depth of the wedge stop (dimension B) in order to obtain as much contact with the wedge as possible without interfering with removal of same. It will be noted that the B dimension is maximum with tolerance of 1/16 in. less, as shown in the tabulation on this sketch.

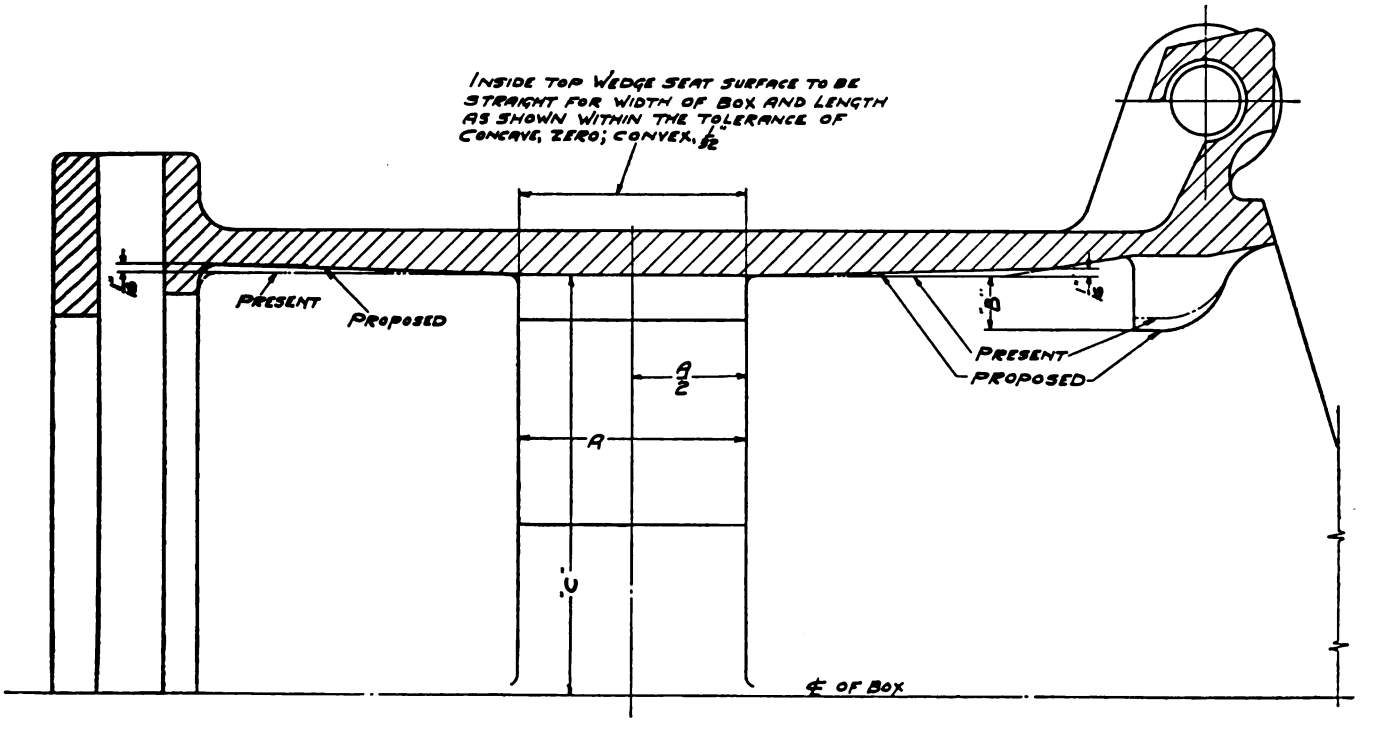
The above suggested changes have been approved by the Car Construction Committee and are concurred in by the Committee on Lubrication of Cars and Locomotives and it is recommended that the arrangement illustrated be submitted to letter ballot for adoption and if approved the drawings in the manual on Pages D-14, D-15, D-16, D-17, D-18 and D-19, will be changed accordingly.

Definitions and Designating Letters

During the past year your committee has passed upon a number of requests from car owners for designating letters for new types of freight and passenger cars. In cases where additions to or changes in the manual are decided upon, the recommendations of other interested divisions of the association were obtained before submitting such changes to the membership by letter ballot.

[The sub-committee here described the letter changes which have already been approved by letter ballot.—EDITOR.]

Your committee has also passed favorably upon new additional designations as follows: *"CSP"—Combined mail-storage or baggage, dormitory and passenger*—A car having three compartments, separated by bulkheads, one for mail storage or baggage,



Class of box	Journal size, in.	A, in.	A/2 in.	B, in.	C, in.
A	3¼ x 7	2⅜	1 3/16	7/16	3⅝
B	4¼ x 8	2⅜	1 3/16	½	4
C	5 x 9	2⅜	1 3/16	⅝	4⅝
D	5½ x 10	2⅜	1 3/16	⅝	4⅞
E	6 x 11	3½	1¾	⅝	5⅜
F	6½ x 12	3½	1¾	⅝	6
Tolerances		+ ...	1/32	0	1/16
		− ...	1/32	1/16	1/16

Fig. 3—Proposed changes in the inside contour at the top of journal boxes

one fitted with sleeping accommodations for the crew and one fitted with seats for passengers.

Reason: To provide for a new type of car.

"BLF"—Flat car—A car constructed and equipped for passenger-train service, especially to carry containers for the transportation of liquids or other commodities.

Reason: To provide for a new type of car.

New Designs of Freight Cars

Since the last report, the committee has reviewed the following business in accordance with the revisions of the first paragraph of Interchange Rule 3.

Five designs, submitted by the American Car and Foundry Company, are for reinforced underframes for cars built to transport 15 1-ton chlorine containers, involving a total of 16 cars. One design was submitted by this company for welded and riveted refrigerator car. One design for a tank car, 50 cars; a modified A. A. R. underframe for tank cars, no limit, and a car structure for carrying 15 one-ton chlorine containers, five cars, were submitted by the General American Transportation Company. A new tank car underframe design was submitted by the Fleischmann Transportation Company covering 40 new underframes and 50 rebuilt underframes. A design of freight car with cradles for handling milk tanks, was submitted by Motor Terminals, Inc. A modified A. A. R. 50-ton hopper-car design was submitted by Berwind White Coal Mining Company. A special tank box car for transportation of liquid oxygen, 10 cars, was submitted by Linde Air Products Company. A light-weight box-car design, submitted by Pullman-Standard Car Manufacturing Company, was previously approved for 1,000 cars; the present approval covers the construction of 1,000 additional cars.

Passenger-Car Axles

In connection with tests of passenger car axles which are being carried on at the Timken plant at Canton, Ohio, the actual tests started on November 20, 1937, and have progressed to the extent that four progress reports have been prepared,* submitted for approval, and then sent out to the member roads. These progress reports show in detail the various designs of axles tested, based on the present A. A. R. 5½-in. by 10-in. journal, having 7-in. wheel seat diameter and black collar. From these tests a new design of axle has been established and is shown in Fig. 4. All of the axles tested were of plain carbon steel, not heat treated after forging, and in accordance with A. A. R. Specification M-101-36, Grade B. The object of these tests was to obtain an axle which would give longer service and life without failure than the present A. A. R. 5½-in. by 10-in. axle. All tests have been confined to improving the axle in the region of the wheel seat inasmuch as most service failures occur inside the wheel fit of the axle a short distance from the inside hub face. To date, these investigations have been limited to those improvements that may be obtained by modifications in design of axles.

The principal modification of design as shown on the attached drawing is increased wheel seat, maintaining the same journal dimension and approximately the same center and the same body dimensions. To check up on the new design, four axles were purchased to specification M-101-36, Grade B, and four axles to the new design to Specification M-104, normalized and tempered. These axles were tested. Axles to Specification M-104, normalized and tempered, did not show up very well and this raised the question as to the value of such treated material. This matter was discussed with the Committee on Specifications for Materials and later, by a joint committee from the specifications committee, the axle committee, and representatives from the manufacturers.

Inasmuch as the new designs have been approved by the Joint Sub-Committee on Axle Research and as this was the first part of the program, the next step was the testing of axles of the new design with a larger number of axles than the eight axles referred to above. This work is now being progressed, the axles having been ordered. As soon as they have been received they will be put in the test machines. The results of these tests will be in a later report.

While all of the work, up to this time, has been in re-designing the regular axles, we are now working on the design for drive axles. This work will be progressed as rapidly as possible and if the design for drive axles can be established it should be included in the letter ballot with the non-drive axles. If it is not completed in time for this, it will be recommended that it be covered by a special letter ballot.

In view of the fact that there are a large number of wheels now in service that in time will require new axles, probably of the new design, we are testing out assemblies with one of the existing 5½ by 10-in. journal axles with a wheel that has a three-quarter inch thick hub and have mounted this axle with pressures for cast iron wheels. These tests will be continued and report furnished later.

As in the case of the number of wheels that will be in existence for some time, consideration is also being given to what changes in machining could be done, such as removing the black collar, so that the life of existing A. A. R. 5½ by 10-in. journal axles may be increased. These tests are being conducted with miniature axles as well as with full size axles. This work will also be hurried to a conclusion.

The Joint Sub-Committee on Axle Research recommends that

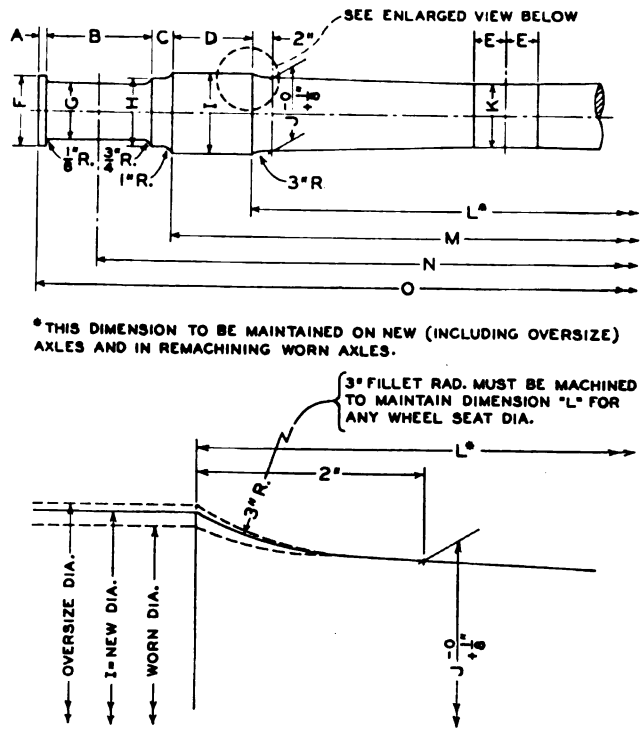


Fig. 4—New A. A. R. axle dimensions—Enlarged view showing condition at fillet joining body of axle to inside edge of wheel seat

* A summary of the fourth progress report is appended at the end of this report on Car Construction.

New A.A.R. Axle Dimensions

Classification of axle	Size of journal, inches	Dimensions, Inches A	B	C	D	E	F	G	H	I	J	K	Feet-Inches L	M	N	O
A	3¼ x 7	5/8	7	2½	7 5/8	1½	4¾	3¾	4¾	5½	4 7/8	4¼	3-11¾	5-3	6-3	6-11¼
B	4¼ x 8	5/8	8	2	7 3/8	1½	5¼	4¼	5¼	6 6/16	5 7/16	4¾	3-11¾	5-3	6-3	7- 0¼
C	5 x 9	¾	9	2	7 3/8	1½	6 1/8	5	6 1/8	7	6 3/16	5 3/8	3-11¾	5-3	6-4	7- 2½
D	5½ x 10	¾	10	2	7 3/8	3	6 3/8	5½	6 3/8	7 9/16	6¾	5 7/8	3-11¾	5-3	6-5	7- 4½
E	6 x 11	7/8	11	2¼	8 1/8	3	7¼	6	7¼	8 3/16	7¼	6 7/16	3-10¼	5-2½	6-6	7- 6¾
F	6½ x 12	7/8	12	2¼	8 1/8	3	7¾	6½	7¾	8¾	7 7/8	6 7/8	3-10¼	5-2½	6-7	7- 8¾

where these axles are used on new cars in passenger service, the load rating of the individual axles should be as follows:

A. A. R. axle designation	Size of journal, in.	Capacity (lb.) for axles for speeds of approximately 100 m.p.h.	Where speeds do not exceed 85 m.p.h., following capacity (lb.) may be used
A	3¼ by 7	12,000	12,500
B	4¼ by 8	19,000	20,500
C	5 by 9	25,500	27,000
D	5½ by 10	32,000	34,000
E	6 by 11	40,000	42,500
F	6½ by 12	48,000	51,000

The Joint Sub-Committee recommends that the new design of axle for 3¼ by 7-in. journals up to and including 6½ by 12-in. be submitted to letter ballot and that the letter ballot also include the ratings established for these axles when used in new passenger car equipment.

This part of the report was signed by W. I. CANTLEY, *Chairman*, Joint Sub-Committee on Axle Research.

Standard Contour for New Passenger Cars

With the advent of streamlined passenger trains, the desirability for uniform exterior appearance of passenger cars has been recognized, and this sub-committee was appointed to make

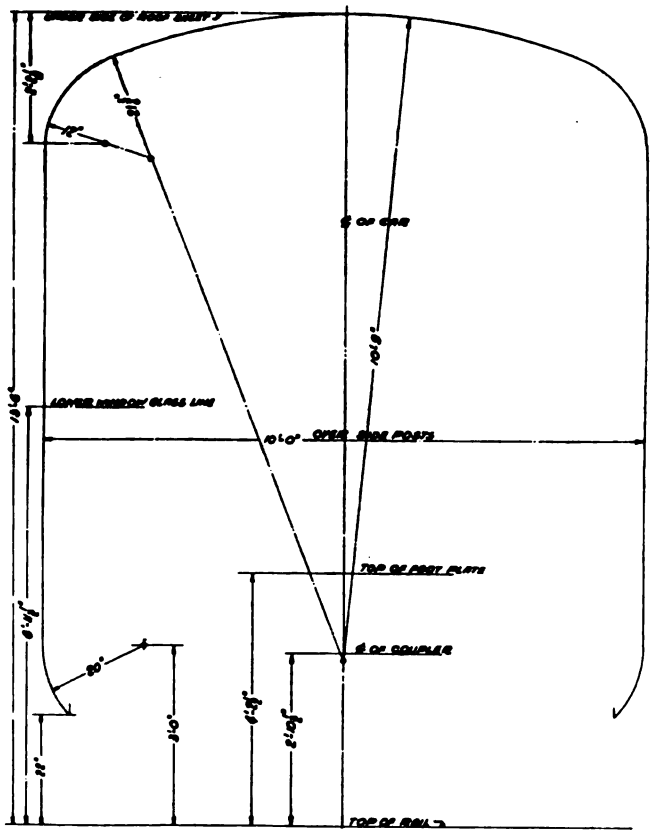


Fig. 5—Standard contour for new passenger cars

a study with a view to developing a standard contour for new passenger cars, that could be followed by railroads and car builders in the interest of improving appearance of passenger trains when cars of various railroads and Pullman equipment are intermingled.

Fig. 5 shows proposed "standard contour for new passenger cars" which has been developed, keeping in mind certain fundamentals such as cross-section of car, over-all height from rail, height of lower glass line from rail, height of foot plate from rail and width over side posts. Another drawing (not included in this abstract of the committee report) indicates the basis on which the proposed contour was arrived at.

It is recommended that contour shown in Fig. 5 be submitted to letter ballot. If approved, drawing will be prepared for inclusion in the Manual.

Lettering and Marking for Automobile Device Cars

To handle satisfactorily some of the newer model automobiles in which the width of bodies has been increased, also some of the models with considerably increased overhang from the center of the rear wheel to the rear end of the body, certain changes are contemplated or are being made in the loaders.

To take care of the wider bodies, 7 in. additional width is being provided between the front arms of the present type D loader, which results in a minimum clear width between the front arms of 82⅝ in. at a point 10 in. above the top of the wheel pan.

To take care of the automobiles with the increased overhang, the width of the rear cross frame on the Type D loader is being decreased from 16 in. to 8 in. It is the recommendation of this sub-committee that, where changes are made in the Type D loader, as referred to above, marking be used as follows:

D Plus—Latest rack having arched 26 in. wide front cross frame, 16 in. wide rear cross frame, 9 point adjustable rear hubs, telescopic front and rear legs and with front arms spread to provide at least 82⅝ in. width in the clear at a point 10 in. above top of wheel pan.

E—Latest rack having arched 26 in. wide front cross frame, rear cross frame reduced from 16 to 8 in. wide, 9 point adjustable rear hubs, telescopic front and rear legs and with front arms spread to provide at least 82⅝ in. width in the clear at a point 10 in. above the wheel pan.

The report was signed by P. W. Kiefer (chairman), chief engineer motive power and rolling stock, N. Y. C.; T. P. Irving (vice-chairman), engineer car construction, C. & O.; W. A. Newman, chief mechanical engineer, Can. Pac.; J. McMullen, superintendent car department, Erie; F. A. Isaacson, engineer car construction, A. T. & S. F.; G. S. Goodwin, mechanical engineer, C. R. I. & P.; H. L. Holland, assistant engineer, B. & O.; E. B. Daily, engineer car construction, Sou. Pac.; J. T. Soderberg, general foreman, Penna.; T. M. Cannon, engineer car construction, C. M. St. P. & P.; and F. J. Jumper, general mechanical engineer, Union Pacific.

Summary of Fourth Progress Report Passenger-Car Axle Tests

[The Summary of the Fourth Progress Report of Passenger-Car Axle Tests, issued on April 1, 1940, is appended here, as it forms the basis for the recommendations of the sub-committee on Passenger-Car Axles in the report above.—EDITOR]

In this fourth progress report the investigation of the influence of the design of the axle on its fatigue strength is practically completed except for generator-drive pulley carrying axles. Three progress reports have been issued since the initiation of the program on the fatigue testing of full size 5½-in. by 10-in. passenger-car axles. This report practically completes the testing program on six different designs of full size axles.

In all six axle designs the allowable design fatigue strength was investigated for both (a) the wheel seat with mounted rolled-steel wheel, and (b) the body portion of the axle included between the wheel seat without the presence of clamped pulleys. No investigation was made of the journal and dust-guard portions of the axle. The results of these tests are shown in Fig. 6 and Table IV.

EFFECT OF AXLE SHAPE

Summary results of all fatigue tests of full size axles for six different designs are shown in comparison with the existing axle designs in the table.

Axle Design 6 is considered as the design for the proposed new axle. It meets the practical requirements for (a) wheel-mounting tolerance conditions, (b) minimizes the scrapping of existing wheels due to having too thin a hub section, and, (c) gives an allowable design fatigue strength in the wheel seat 60 per cent to 80 per cent greater than the present design of axle (Design No. 1).

The increase in the 7-in. wheel-seat diameter of the present axle (Design 1) to 7 9/16 in. in the proposed new axle (Design 6) is accountable for 25 per cent increased strength. The remainder of the increased fatigue strength obtained is due to a change in the shape of the axle wheel seat, whereby the black collar is eliminated and a raised wheel seat is formed on the axle.

All these tests on axle shape were made on steel to A. A. R. Specification M-101.

Effect of Axle Material

A total of 87 full-size axles have been tested from as-forged material to A. A. R. Specification M-101. Only a total of eight axles have been tested from normalized and tempered material to both A. A. R. Specifications M-104, Class A and M-101. The limited number of tests made on normalized and tempered axles does not justify definite conclusions at this time and additional axle tests will be made.

A number of machined axle forgings from M-101 material were originally supplied at the beginning of the axle test program for use with 8⅛-in. diameter wheel seats (Design 3). It was not found necessary to use all these axles for the original purpose for which they were intended and it was decided to test these remaining axles after turning the wheel seat for the next smaller wheel seat diameter of about 7⅝-in. (Design 2, 4 and 6).

Tests of these axles showed that the fatigue strength varied from zero to 10 per cent less than for similar axles machined from the proper forging size. Axle life is also less. It is apparent that the practice of machining smaller axles from larger axles may lead to a loss in axle fatigue strength as determined from the use of M-101 steel used in these tests.

Re-design of Axles in A. A. R. Classifications

Recommendations are contained in this report for the dimensions of the re-designed axles in classifications A through F and recommended designs of two additional axle sizes, 7 in. by 13 in., and 7½ in. by 14 in. (See Table V.) Such re-design was based on the test results of the proposed new 5½-in. by 10-in. axle known as Design No. 6.* The other axles were then re-designed to be geometrically similar to the new 5½-in. by 10-in. axle.

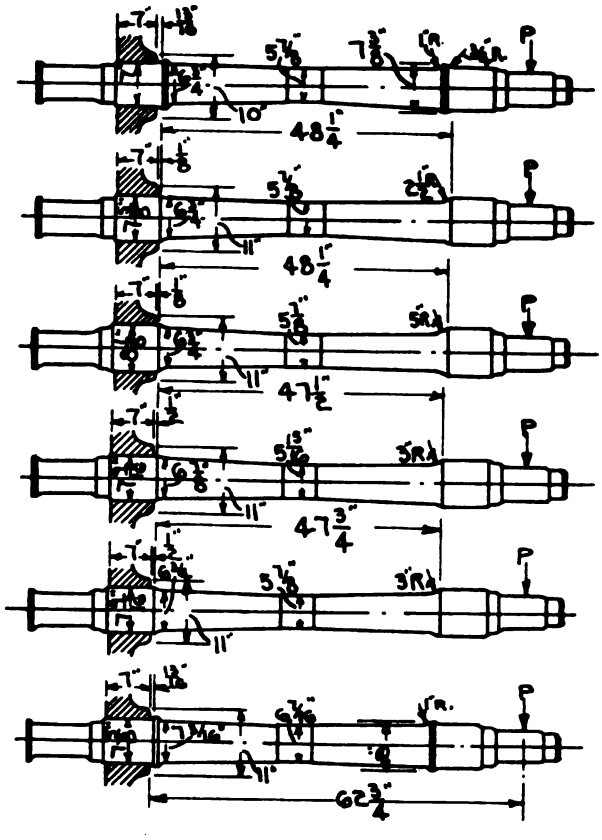


Fig. 6—Top to bottom—Axles designs Nos. 1, 2, 3, 4, 6 and 5. A summary of results of fatigue tests on these axles are shown in Table IV

These proposed new axle dimensions give an increase of about 60 to 80 per cent in the allowable design fatigue strength of the wheel seat over that of the existing axle designs. The diameter of the body portion of these re-designed axles at the center is the same and the body taper is practically the same as on existing axles. It is the intention later to provide a separate design of axle in the center portion to improve the fatigue strength of the existing axle due to detrimental clamping effect of the drive pulley.

The method used in calculating the axle stresses is classified as "modified Reuleaux method." This modified method is very nearly identical to that given by the Car Construction report contained in the 1920 Proceedings of the Mechanical Division of the A. R. A. beginning on page 759. The reason for using the modified method rather than that recommended in the 1920 Proceedings is that the formulas and calculations are simplified and the resulting stresses are only about three per cent higher; also in view of the empirical nature of these formulas it is believed that this simplification is justified. Until further information is available on stresses developed in axles in road service the method used in this report is recommended.

The new axle designs when used in passenger service are calculated to have about 84 per cent of their capacity in freight service. This reduction in capacity is due partly to the fact that passenger-car wheels are 36 in. instead of 33 in. in diameter, but the greater part of the reduction in capacity results because a greater horizontal flange thrust must be assumed in order to cause overturning of a passenger car having a 54-in. center of gravity height compared with 72-in. center of gravity height assumed for freight cars. If the same horizontal flange thrust were assumed for freight and passenger cars, the axles would have about one per cent greater capacity for passenger service than for freight service because the increase in stress due to larger wheel diameter in passenger service would be more than offset by the decrease in stress due to lower center of gravity of passenger cars.

Effect of Clamping Generator Pulleys on Axles

Investigation is underway on ¼ scale size axle tests of M-101 material to determine the detrimental effect on the fatigue strength of the body of the axle due to clamping of a generator drive pulley. Means of improving this axle fatigue strength are also being tested. None of these tests have progressed far enough to arrive at even tentative conclusions.

Effect of Reducing Wheel-Hub Thickness

Increasing the wheel-seat diameter on the proposed new axle designs will, in accordance with existing rules, scrap a number of wheels due to having too thin a hub section. Test of a full-size axle (Design 1) was therefore just initiated where the rolled-steel wheel-hub section was made ¾ in. thick at both hub faces. The press fit of the wheel on this axle was .0047 in., giving a mounting tonnage of 45 tons. If the test of this one wheel and axle assembly is satisfactory additional tests will be

* The dimensions of re-designed axles classifications A through F are set forth in the section on Passenger-Car Axles in the above report.

Table IV—Summary of Results of Fatigue Tests Made on Six Designs of Full-Size Axles

Axle design no.	Steel spec.	Allowable maximum axle bending stress in wheel seat to prevent: Initiation of fatigue cracks, Lb. per sq. in.	Initiation of fatigue cracks, Per cent	Breaking off of axle, Lb. per sq. in.	Breaking off of axle, Per cent	Increased axle fatigue strength against cracking in wheel seat due to elimination of black collar and use of raised wheel seat, per cent	Fatigue strength of body, Lb. per sq. in.	Fatigue strength of body, Per cent	Comparison of axle capacity: Not to crack in wheel seat	Comparison of axle capacity: Not to break in body
1	M-101	9,000	100	11,000	100	..	17,500	100	1.00	1.00
2	M-101	12,000	133	14,000	127	33	17,500	100	1.72	1.00
3	M-101	13,500	150	16,000	145	50	17,500	100	2.35	1.00
4 } 6 }	M-101	12,000	133	14,000	127	33	17,500	100	1.69	1.03 / 1.00
5	M-101	9,000	100	11,000	100	..	17,500	100	1.29	1.26

Table V—Dimensions of 7-in. by 13-in. and 7½-in. by 14-in. Tender Axles

Size of journal, in.	Dimensions, ft.-in. A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
7 x 13.....	7/8	13	2¼	8⅛	3	8½	7	8½	9⅜	8 7/16	7⅜	3-10¼	5-2½	6-8	7-10¾
7½ x 14.....	7/8	14	2¼	8⅛	3	9	7½	9	9⅞	8⅞	7¾	3-10¼	5-2½	6-9	8- 0¾

NOTE.—For location of these dimensions see Fig. 4 included with dimensions of axles, classifications *A* through *F*, in the section of the report on Passenger-Car Axles.

necessary further to determine if it is practical to use ¾-in. hub thickness in service in order to avoid scrapping wheels.

The object of this test is:

(1) To determine if the hub of the wheel will fail with the minimum ¾-in. hub thickness shown. The reason for desiring to have this information is that the proposed new design of axle will scrap a number of wheels because of the present rules as to minimum wheel-hub section thickness.

(2) The thinner hub section may increase the fatigue strength of the axle in the wheel seat portions.

(3) The reason for machining out the wheel disc on the journal side of the axle is to determine from these tests if the light wheel-hub section will have sufficient holding power on the axle to prevent the axle pulling out of the wheel during the test.

(4) It is also desired to mount this wheel on the axle within the tonnage limits now specified for cast-iron wheels on axles instead of using the tonnage limitation now provided for steel wheels.

Discussion

In discussing this report, A. J. Krueger, superintendent car department, Nickel Plate, said that in his opinion the so-called modern lightweight steel freight car has not been in service long enough to permit evaluating all of the economic factors and mechanical details, such as initial cost, maintenance, weight saving, sizes of material, spring suspension, side bearings, brakes, draft gears, trucks, etc. Mr. Krueger said that the future design of such cars will depend upon service results with respect to full protection against corrosion at all metal joints; resistance of the material itself to distortion and rupture on account of increased flexure; degree of acceleration of such distortion or rupture resistance of the parent metal to oxidation; affinity between the parent metal and paint materials; service life as affected by the degree of welded or riveted construction employed; practicability of maintaining cars with present repair track facilities; and the resistance of the new steels to impact loading or stress at low temperatures.

Mr. Krueger congratulated the committee on its constructive report and urged further cooperation of all railroads in furnishing information regarding service performance so that the joint efforts of car builders, railroads and car operators may result in establishing the characteristics of the most economical car unit. Regarding the question of how much rigidity of flexibility should be built into a car design, Mr. Krueger said there is some question and mentioned the experience of welding pipes to cross members, bolsters, etc., in cars with results which, in his judgment, have proven to be undesirable.

K. F. Nystrom, mechanical assistant to chief operating officer, C. M. St. P. & P., offered a resolution that the committee be asked to specify the point at which the side sheet should end and the skirting begin on the passenger-car cross-section contour proposed by the committee. Mr. Nystrom offered no objection to the contour itself, but in view of the fact that some roads are not favorably inclined to the use of the skirting, felt that the location on the drawing of the point referred to would tend toward uniformity of treatment in such cases. The resolution was adopted and Mr. Kiefer said that the committee would be glad to consider the location of the point in question.

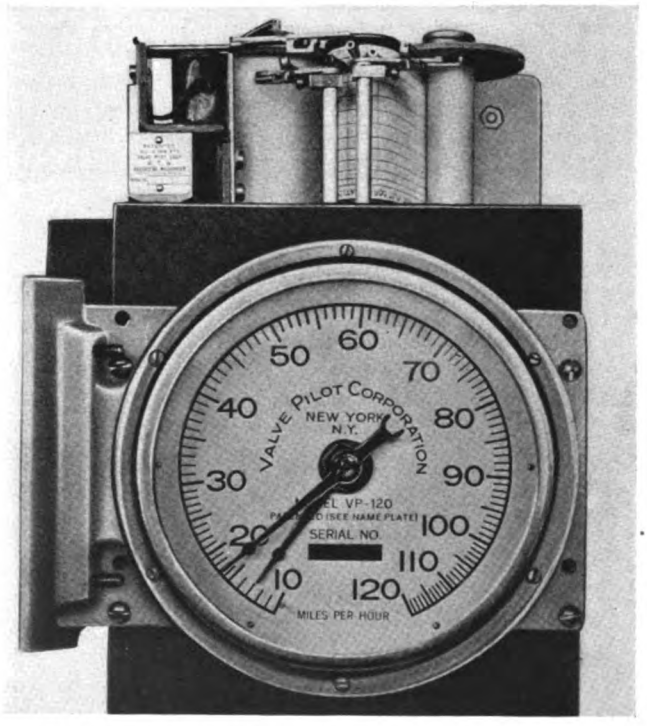
In closing this report, Chairman Kiefer said that the original standard box car of 1932 demonstrated about 20 per cent greater strength than the conventional cars with which it was checked in comparative tests and this car is generally accepted as the yardstick for durability of freight equipment. He said that car life is an important factor which must not be sacrificed for the sake of light weight and the effort has been to produce a car in which weight is saved without reducing the prospective car life.

D. S. Ellis, chief mechanical officer, C. & O., complimented the committee on producing a constructive report which obviously represented the expenditure of a great amount of time and effort. He moved that the committee be extended a vote of thanks and the report be accepted with recommendations submitted to letter ballot. *This motion was carried.*

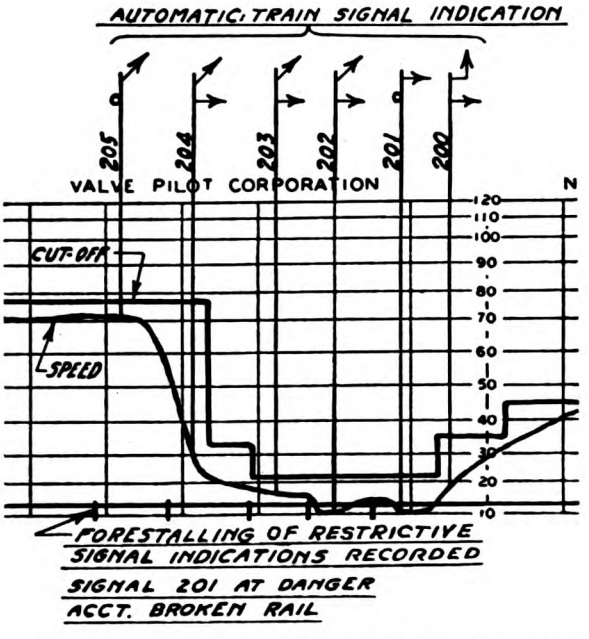
Automatic Train-Signal Recorder

A novel piece of equipment recently added to the locomotive Valve Pilot furnishes an autographic record of forestalling at restrictive signals in train-control territory. The automatic record is made on the tape in addition to its present records which show speed and cut-off.

The operation of the automatic train-signal recorder is controlled by an electro-pneumatic switch in the forestalling circuit of the train-control mechanism, the switch being closed by the admission of air to the warning whistle at the moment of forestalling. When the switch is closed the current energizes an electro-magnet located in the recording compartment of the instrument and causes a pencil attached to the armature of the electro-magnet to make a short mark at right angles to the direction of travel of the tape. Except when forestalling occurs, the pencil simply draws a straight line near the edge of the tape parallel with the horizontal ruling. The electro-magnet and pencil arm applied to an instrument are shown in one of the illustrations. The other is a reproduction of a short section of tape and indicates the character of the record when the engineman fore-



The electro-magnet and pencil arm for the automatic train-signal recorder installed on the Valve Pilot



The autographic record of forestalling made by the signal recorder is shown on the section of tape

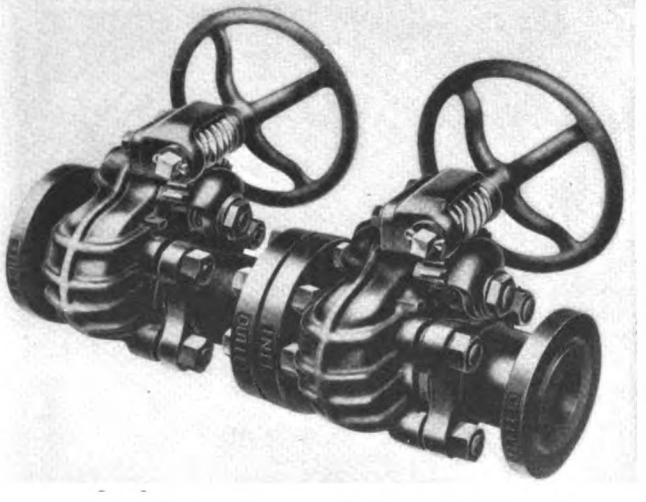
stalls at a point where a restrictive signal is encountered and the analysis of the operation.

This device added to the Valve Pilot further improves the safety of railroad operation by giving the management a written record of alertness in the observance of operating rules relating to restrictive signal indications in train-control territory. It is a development of the Valve Pilot Corporation, New York.

Blow-Off Valve for Enginehouse and Power Plant

The Okadee Company, Chicago, has recently introduced a new line of blow-off valves for enginehouse and power-plant service patterned after its locomotive blow-off valves. Threaded or flanged types of these valves are made in sizes ranging from ½ in. to 6 in. and in a single-seat design, controlling pressure in one direction, or in a double-seat style, controlling pressure in both directions. High-tensile iron castings are used in the body and outlet for low pressures and electric-steel castings for higher pressures. The valves are operated either by a lever, rack and pinion or gear mechanism. The seats and discs are available in a hardened alloy material, hardened stainless steel or Stellite surfaced.

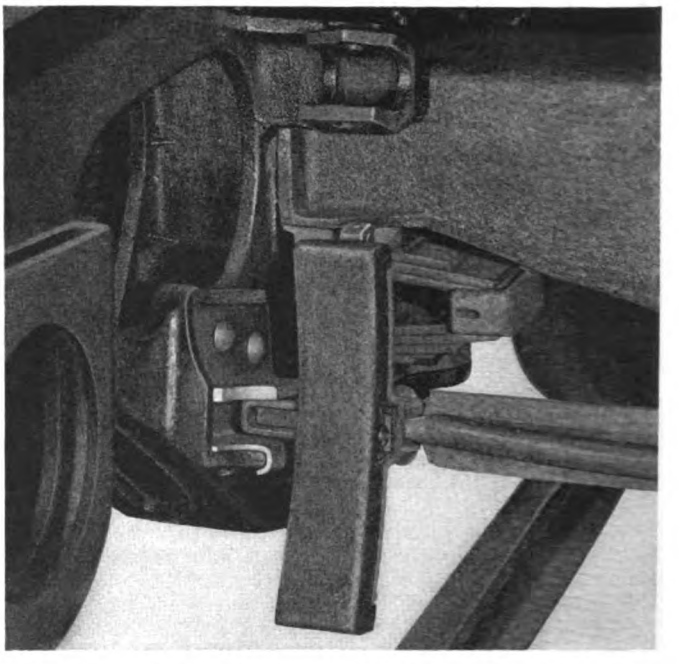
When the valves are used in direct steam lines in enginehouses, they are equipped with chain wheels for operation from the floor. For this type of service the full opening through the valve greatly reduces the time required to empty or fill up a boiler. A complete line of these valves is available for power-plant blow-down lines, water walls, soot blowers, and other uses which are designed to meet all requirements of the A. S. M. E. Power Boiler Code.



Two Oakdee blow-off valves in combination

Unit Truck and Brake Beam

The Unit truck combines a modern high-speed truck with foundation brakes interlocked in the truck side frame. The side frames are of approved design with the bottom brake-beam guide cast integral at an angle of 14 deg. on a radial line to the center of the axle. The top portion of the guide is attached to the frame by two ¾-in. rivets. This part of the guide secures the wear plate which protects the cast guide from wear. The



The brake beam of the Unit truck operates in guides—The truck is protected in interchange by conventional brake-hanger brackets

guide, it will be noted from the illustration, forms a socket for accepting the Unit brake beam.

The Unit brake beam is a solid forged truss having extended ends protected by 2⅝-in. by 5-in. wear plates forming 26 sq. in. of bearing surface. The brake beam operates in the truck-frame guides which allows for the full floating beam necessary on the flexible type of trucks. The brake head is reversible and the strut is of special design. The pin hole is bushed and the bottom of the lever slot is closed for safety. The truck has conventional brake-hanger brackets to protect in interchange.

Comparative tests of this truck with the conventional

(*Continued on page 293*)

EDITORIALS

Railway Capacity For National Defense

C. H. Buford, vice-president, Operations and Maintenance Department, Association of American Railroads, speaking at the recent meeting of the Mechanical Division at Chicago on the ability of the railroads to meet any demands placed on them by the preparedness program on which the nation seems about to enter, said that "From a careful study of our loading record during the World War and since that time, we can find no basis for an estimated loading at the peak this year that will be in excess of what the railroads can handle. Unless there is a real need for additional equipment or unless there is some economy to be gained by adding cars and locomotives, there is no reason why the railroads should buy them or put money into repairing bad-order equipment."

There is no reason to question the essential accuracy of this statement so far as the capacity of cars and locomotives to move any volume of freight which the railroads are likely to have offered to them during the present year. It is questionable whether the industrial capacity of the nation can be expanded at so rapid a rate that the railroads cannot adjust themselves to the maximum demands probable during the peak movement of the coming autumn.

There are other aspects of the situation, however, which must be faced. First, there is a distinction between the mere capacity to move a maximum volume of freight traffic and the ability to move it with economy. The latter depends upon the character of the cars and locomotives which make up the capacity. It is well known that too large a percentage of our freight motive power is of a vintage which is incapable of moving traffic economically under present-day operating conditions and there are still many old cars which are likely to require too frequent detention on repair tracks when drafted into active service.

Second, if the intentions of our national government with respect to preparedness for national defense are serious and an adequate program is carried through to completion, the industrial output of this nation will by no means reach its peak during the current year. The question arises, what of 1941 and 1942? When production schedules for armament and munitions get under way it may be far more difficult to secure deliveries on railway motive power and rolling stock needed to meet succeeding traffic peaks, each higher than its predecessor.

In a study of maximum motive power and rolling stock capacity, it is well to bear in mind that before a shortage of equipment is indicated on a national basis, local pinches will have been developing for some time on various individual railroads. Such pinches undoubtedly have been a factor in the increase in orders for locomotives and freight cars placed during the month of June when orders were placed for about 40 per cent of all cars ordered since the first of the year.

Certainly, there is not likely to be a better time than the present for those roads which can profit in economy by the purchase of new motive power and rolling stock or which are likely to need additional capacity within the next year or two to place their orders. The difficulties in the way of deliveries may very well become increasingly acute within the next few months.

Mechanical Officers Hold Excellent Meeting

The eighteenth annual meeting of the A. A. R., Mechanical division, held June 27 and 28 at Chicago, as reported elsewhere in this issue, was definitely a business session, without exhibits or entertainment features of any kind and with only one break in the program of addresses and committee reports, namely, the interjection of an educational film, "Know Your Money," by the United States Secret Service—Treasury Department, at the beginning of the second day. Some 200 railway mechanical officers were in attendance and, while some of the more or less routine reports were accepted without discussion, a number of subjects such as wheels, couplers, loading rules, and car and locomotive design developed many pertinent comments of definitely constructive character. The meeting was ably presided over by Chairman F. W. Hankins, assistant vice-president and chief of motive power, Pennsylvania. Vice-Chairman W. H. Flynn, general superintendent motive power and rolling stock, New York Central, did not have much to say, but evidently was making mental notes for use in guiding the affairs of the division during the coming years.

In general, the reports of the eleven standing committees were unspectacular, at least from the point of view of the lay reader who must have war news or at least a murder or a divorce headline to attract his interest in a newspaper. It may be said without fear of contradiction, however, that these reports, almost without exception, dealt with matters of vital importance to the safety and economy of rail transportation, and it is no reflection on, but rather a tribute to, the railway officers who know most about these things that they

discussed them both quietly and competently and in a most matter-of-fact fashion. Probably few people outside the ranks of the Mechanical division, itself, realize just how much time and effort are expended by the General committee and various standing committees in preparing for these annual meetings and how much good judgment and experienced supervision of a vast amount of details must be exercised by Secretary V. R. Hawthorne and his office.

Among the outstanding jobs done by the A. A. R., Mechanical division, during the past year was the continued revision of the interchange rules to promote the more expeditious movement of freight traffic and the re-adjustment of labor, material and overhead charges so as to eliminate profit from foreign car repairs. Loading rules were studied and revised especially with a view to the more safe and at the same time economical loading of open-top cars. The discussion indicated that all railroads have not helped as much as they should by reporting the adjustment or transfer of loads. In view of the need for more prompt application of improved loading practices, it was decided that necessary revisions in the loading rules should be approved at the annual meeting or at General Committee meetings throughout the year without the delay involved in submitting them to letter ballot. This is an evidence of the adjustment of mechanical-department officers to the needs of the railways in their competition for traffic with highway transportation agencies.

An exceptionally interesting subject presented at the annual meeting this year was the results to date of the passenger-car-axle research program, being conducted at the laboratory of the Timken Roller Bearing Company under the direction of W. I. Cantley, mechanical engineer of the division and a special joint sub-committee. This work has led to a redesign of passenger-car-axle wheels seats which, partly as the result of the increase in wheel-seat diameter and partly as the result of the elimination of the black collar included on current designs, has increased the allowable design fatigue strength of the wheel seat about 60 to 80 per cent over that of the existing axles. This means much for the future reliability and economy in high-speed passenger-train service. The division has other pertinent investigations in prospect and it is gratifying to note that the potential importance of research activities heading up in the mechanical engineer's office has been recognized by recently giving Mr. Cantley an experienced assistant.

The division reports progress in providing dies for the manufacture of parts for the A. A. R. design of auto deck which has been demonstrated at practically all automobile-loading docks; consideration is being given to developing a standard clearance outline for interchange freight cars; in co-operation with other divisions of the A. A. R., studies are being made of (a) the effect of light cracks around refrigerator car doors and hatch plugs, (b) use of dry ice in refrigerator cars, (c) use of portable refrigerator containers for l. c. l. shipments. The results of the A. A. R. high-speed freight-car track tests are expected to be released some time this month.

Diesel Locomotive Operating Costs

In presenting its report to the railroad industry, and to others that may be interested in the question of the cost of operating Diesel-electric locomotives, the sub-committee of the Locomotive Construction Committee of the Mechanical Division has done a worthwhile job in the tabulation of the cost of operation of switching locomotives. Such reports as these are especially valuable in connection with the operating results obtained by the use of a facility that is relatively new in the industry and concerning which there has been a considerable amount of controversy during the initial years of its installation.

The controversy is by no means settled in the minds of many railroad men who are unwilling to concede what now seems to be definitely established advantages in favor of the Diesel locomotive in specific classes of service. Herein lies the real value of the work that has been done by a committee such as has presented this year's report—it has added to the sum total of our factual information concerning a phase of railroad operation that is going to be of vital importance to the future of the industry.

The statistical information contained in the sub-committee's report concerning installations of Diesel locomotives is of interest in several respects. It shows that at the beginning of this year 749 Diesel locomotives had been installed on the railroads and that 57 more were on order. Of the 749 locomotives in service 681 are units of 1,000 hp. or less, and all but 11 of this large group are in switching service. There are 40 locomotives in the group from 1,000 to 2,000 hp., six of which are switchers and the remaining 34 are road locomotives. In the horsepower ranges above 2,000 all of the locomotives are in road service and there are 28 locomotives in that group.

The installation statistics show some interesting trends in the switching field. Up to 1931 most of the switchers were of from 300 to 400 hp. At that time 95 units in that horsepower range had been installed as compared with only 19 in the 600 hp. class. It is probable that most of the 600 units of that time were two-engine locomotives powered by a pair of 300 hp. engines. From 1932 to 1936 the trend was definitely toward the larger units, for in that five-year period 65 switchers of 600 hp. were installed as compared with only 7 of the 300-400 hp. group. It was in this period, too, that the development of the larger engines made possible the construction of single-engined switchers and with this development the 600 hp. unit really came into its own and established a popularity which has been on the increase ever since, as witnessed by installations of 87, 50 and 107 respectively for the years 1937, 1938 and 1939. Added to this group are 25

units of 660 hp. During the same period 79 switchers of 900 hp. were placed in service.

So much for the statistical side of the committee's report. It is of interest as an indication of the increasing importance of the Diesel locomotive in the rail transportation field and also it establishes certain facts that have a bearing on any statistics concerning the cost of Diesel locomotive operation.

An analysis of the cost figures developed by the sub-committee in the 1940 report presents some interesting indications of what may be expected in the future as far as the cost of this type of motive power is concerned. The tabulation of costs, for a six-months test period in the year 1939, is also of interest when compared with the similar tabulation which was a part of the 1939 report to the Division. The 1940 report includes comparative costs of 600 and 900 hp. locomotives, while the 1939 report included only the 600 hp. units. All of these cost figures relate only to switching locomotives. The 600 hp. switchers operated 87.8 per cent of their assigned hours. The actual total hours operated by 71 units on eight roads was 262,868 and for this service the fuel oil average was 5.63 gal. per hour and the lubricating oil average was .13 gal. per hour. This would indicate a fuel cost of close to 30 cents per hour.

In the 1939 report 51 units operating a total of 1,227,888 hours averaged 6.591 gal. of fuel per hour and .1244 gal. of lubricating oil per hour. These figures may indicate a change in the load factor for 600 hp. switchers as between the two years or they may indicate the influence of the more modern and more efficient prime movers in switchers recently installed.

The 900 hp. switchers operated 91.6 per cent of their assignments for a total of 101,762 hours, on six different roads. The fuel consumption averaged 6.371 gal. per hour and the lubricating oil average was .1606 gal. per hour. Here we have an indicated average of about 33 cents per hour for fuel and 8 cents for lubricating oil. These figures can hardly be questioned and they provide a reliable base for building up 900 hp. total cost figures.

The maintenance cost figures are certain to be of greater interest, for here is where some of the controversy lies. In the 1939 report the average cost for maintenance of 51 locomotives of 600 hp. was $0.5726 per hour. The 1940 report gives the cost (over a six-months period) for the same size of locomotive as $0.3038 per hour, and for the 900 hp. unit as $0.2755. If cost studies for short periods of service are an accurate indicator then the principal conclusion to be drawn from these figures is that the greater age of the 600 hp. switchers now in service is bringing them into the periods of major repairs and that the more modern units are considerably less expensive to maintain than the older ones.

It is to be regretted that the cost studies in the 1940 report did not embrace "enginehouse expense" and miscellaneous cost items. These are needed to complete the picture and may prove of great value in the future as the installation of Diesel locomotives continues to be made.

In one respect the closing remarks of the sub-committee in the 1940 report leaves us with mixed feelings, for they say that "it is felt that sufficient information is available to justify consideration of suspension, for the present, at least, of activities of this committee, and it is so recommended." Whatever may be the reason for suspending the activities of this sub-committee—and the report was accepted by the Division—there are a multitude of people interested in the economics of Diesel operation who will take issue with any assumption that sufficient information, of an accurate character, is available to meet the needs of future studies.

It may be true that operation cost studies are somewhat outside the function of the Locomotive Construction Committee but there is a strong feeling on the part of many railroad men that a permanent study of costs should be set up and it is to be hoped that the A. A. R. will recognize this. The interest of the American Society of Mechanical Engineers in Diesel locomotive costs is evidence that the job is by no means done; in fact it has only started.

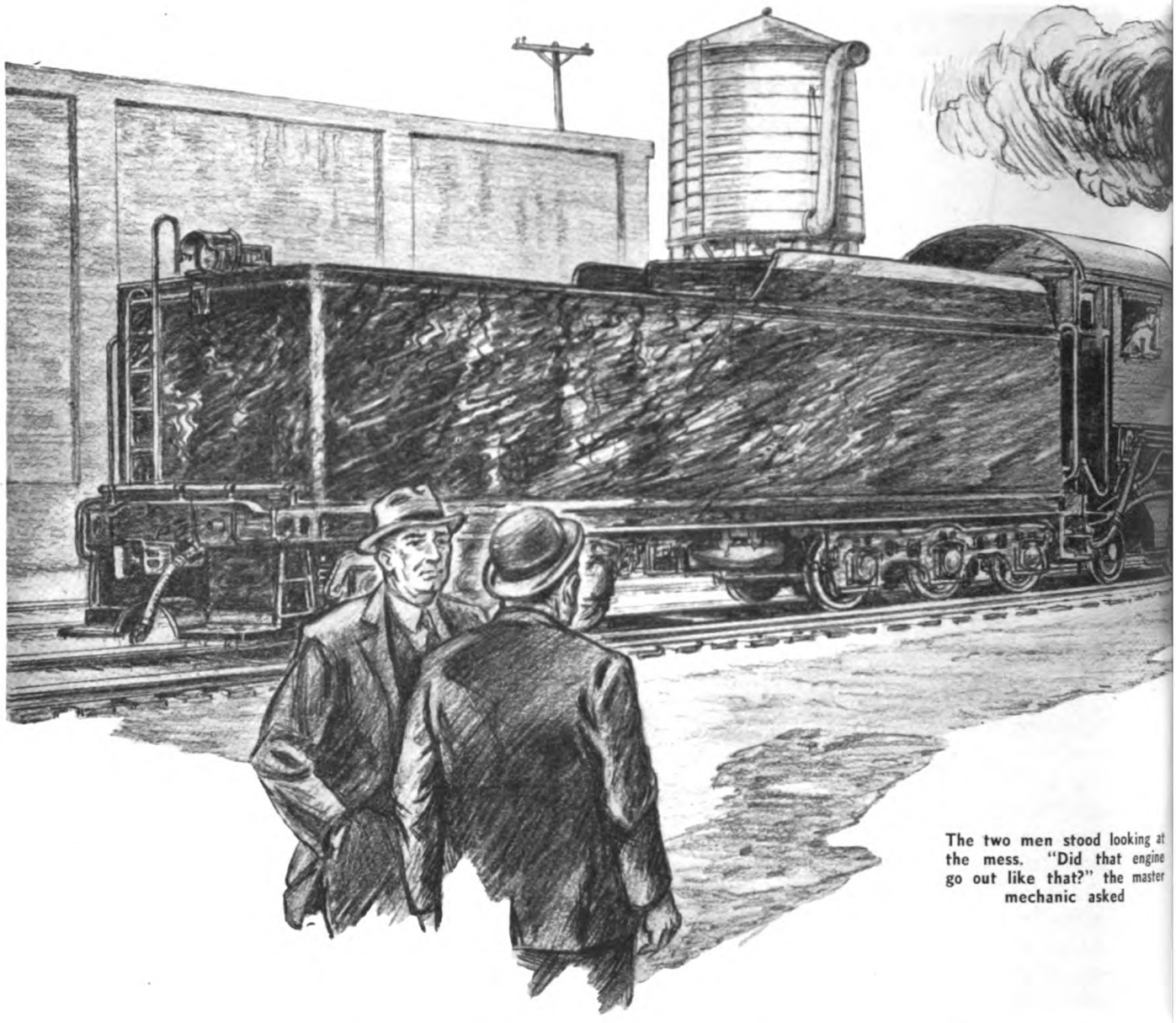
New Books

A Dictionary of Metals and Their Alloys. *Edited by F. J. Camm. Published by the Chemical Publishing Co., Inc., 148 N. Lafayette St., New York. 245 pages, 5½ by 8½ in. Price, $3.*

This book contains descriptions of the metals, their composition and characteristics, with special sections on plating, polishing, hardening and tempering, metal spraying, rust-proofing, and chemical coloring, and useful tables. It is believed to be the first alphabetically arranged dictionary of metals and their alloys yet published. It is cross-referenced throughout and, where necessary, historical facts have been included.

Proceedings Association of American Railroads, Mechanical Division, 1938-39. *Published by the association, 59 E. Van Buren street, Chicago. 780 pages. Price to members $5; to non-members $10.*

The sessions of the Operations and Maintenance Department, Mechanical Division, held at the Hotel Commodore, New York, June 28-30, are covered in the 1938-39 proceedings, also recommendations, letter ballots and other transactions for the two years. The subjects reported on at the New York meeting were lubrication of cars and locomotives; specifications for materials; wheels; brakes and brake equipment; arbitration; prices for labor and materials; tank cars; loading rules; couplers and draft gears; car construction; reciprocating steam locomotives, and utilization of locomotives. Bound in at the back cover of the proceedings are Summary Sheets of Operating Statistics, Class I Railroads, Year 1938 compared with Year 1937, which formed a part of the report of the Committee on Utilization of Locomotives.



The two men stood looking at the mess. "Did that engine go out like that?" the master mechanic asked

Water On The Troubled Oil

by
Walt Wyre

THE S. P. & W. was one of the first railroads to begin burning oil in locomotive fire boxes. Like all pioneers, they had considerable trouble when they first began using the sticky black liquid—at least it's a liquid when it's hot. They still have some trouble, usually just trifles but enough to provide an alibi for firemen and small enough to be repaired without a great deal of work.

No one on the S. P. & W. knew very much about firing with oil when they began. Jack Phillips, the fuel supervisor knew plenty about coal. He cut his teeth on a hunk of soft coal and used a worn out scoop shovel for a stick-horse when he was that age. Jack learned a lot about burning oil and he learned something else doing it. He learned that just because a kid is fresh out of college is no sign that there are no sensible ideas in his head.

Jim Evans, the roundhouse foreman at Plainville, almost went nuts while the change from coal to oil was being made. Most of the work was done at Plainville and dragged along for about a year. The engines being converted took up roundhouse room that was needed for running repairs and boilermakers were so busy on the new work that they didn't have time to keep the boiler work up on other locomotives.

Martin Caldwell, a kid with the ink not yet dry on his college diploma, was sent to Plainville to help Phillips work out various problems that might come up with the new fuel. Martin was a chemistry major and had made a specialty of petroleum. The two didn't hit it off from the start; at least Phillips didn't like his assistant and didn't care who knew it, Caldwell included. Martin was agreeable to everybody and if he knew he was being ridden never let on. He fixed up a laboratory in one corner of the cubby hole they gave him for an office and spent considerable time fooling with flash cups, Bunsen burners, thermometers, and things like that. He



had a lot of instruments Phillips couldn't even pronounce the names of.

One day the fuel foreman went into the combination office and laboratory while Martin was testing samples of a new lot of fuel oil. The assistant was watching a stop watch with one eye and the instruments with the other.

"What's that thing?" Phillips asked with a sneer in his voice.

"It's a viscometer," Caldwell replied without taking his eye off the instrument. A drop fell and he made a note of the time in a little black book.

"What the hell is a vis—vis—that thing—supposed to do?—fire a locomotive?"

"No," Martin replied evenly, "it tells the viscosity of the oil at various temperatures—how hot it has to be to flow." He took another sample of oil and placed it in a flash cup and set the cup in a wire frame over a gas burner. He then stuck the bulb of a thermometer in the oil.

"What are you doing now?" Phillips asked in a tone that indicated that whatever the chemist was doing would be just as well left undone.

"Testing the flash point." Martin watched the oil and thermometer. He struck a match and held the blaze over the cup of oil.

"Even you ought to know that you can't set that stuff a-fire holding a match over it," Phillips scoffed. "It won't hardly burn if you pour kerosene over it."

Every few seconds Martin tried to see if the oil would flash. When bluish vapor curled up from the oil he tried again and the vapor ignited. Martin made another notation in his book and kept on heating the oil. He continued to heat the oil until it could be lighted and continue to burn. Then he turned off the gas from the burner and extinguished the burning oil by slapping a piece of cardboard on top of the cup.

"Now I guess you can go out and fire a locomotive with it," Phillips said.

"There are certain specifications required when we buy oil," Martin replied, "and I was just making certain that it meets those requirements. This is pretty good oil. It's from the Carborex Company. Their oil seems to be better than any of the other I've tested."

"Have you tried it in a locomotive?" With that shot, Phillips turned and left the office.

THE 5091 was the first engine finished. Phillips and his assistant both rode it on the first trip.

The engine didn't do so good with the ninety-two loads the dispatcher hung on it. Try as he would, the fireman couldn't keep steam. When the oil valve was wide open, the locomotive smoked like a tar kiln and before they reached Sanford hunks of carbon had accumulated in the channel in front of the burner. They had to stop and raise steam to keep from doubling Clear Creek hill.

When the fireman couldn't make a go of it, Phillips took the seat on the left side and tried it. He jiggled the fuel valve, tried different amounts of steam on the atomizer valve, but the engine just wouldn't steam. He swore a streak that should have made the boiler pop, but it didn't.

"Why don't you do something?" he yelled at Martin. "Maybe if you had a test tube and a thermometer you might make this blamed stuff burn! Why don't you do something?" he yelled again.

"Nothing we can do until we get the engine to a shop," Martin replied.

"Maybe you think you know what's the matter with it," the fuel foreman said sarcastically.

"Yes," Caldwell replied, "at least I know partly why it isn't steaming. It's not getting enough air and the burner is set too low. That's part of the cause for the carbon in the channel. Giving it more oil than will burn only makes it worse," he added as Phillips yanked the valve.

Phillips wanted to cut the 5091 out at Sanford.

"I believe if we cut a couple of slots about two inches wide and twelve inches long on each side of the boot and raise the burner a little it might do better," Martin suggested.

The fuel supervisor started to argue, but changed his mind and said, "O. K., if you want to be responsible for the delay. We've already fell down over an hour."

A machinist using a cutting torch cut the openings in the boot under the direction of Martin. The same machinist adjusted the burner so that the spray of steam driven oil was slightly higher. Phillips stood by and watched. The expression on his face showed very clearly that the whole business was just some more of his assistant's tomfoolery.

The carbon was cleaned out of the channel and Martin said he believed the engine was ready to go. Phillips lighted a ball of oily waste and threw it in the firebox and started to take hold of the firing valve.

"If you don't mind, I'd like to try firing her awhile," Martin said as he edged over to the left side of the locomotive and very innocently got between Phillips and the valve.

"Why you young cub!" Phillips came very near letting his temper get away for a moment, "I was firing a locomotive before you quit wetting the bed!"

Martin's eyes flashed, his face reddened. There was trace of a tremor in his voice, but he spoke evenly. "You said that I was to be responsible."

"O. K., she's your baby!"

The 5091 did better the rest of the trip. The train

made running time, but failed to make up any that had been lost between Plainville and Sanford. All of the other engines that came out later had slots in the sides of the boot, though; the fuel supervisor saw to that.

After the trip with the 5091, Phillips eased up on his assistant a little and was even known to ask Martin's opinion on a few points. One day Phillips came in Martin's office carrying a bucket of oil.

"Test this and see how it shows up," Phillips requested.

The chemist started immediately. "This is not Carborex, is it?" he asked after examining the oil.

"What difference does it make?" Phillips asked sharply. "Oil is oil, isn't it? I made a pretty good deal for this oil from an independent company. We get all of their business if we buy their fuel oil. Their chemist said it would test better than what we are getting from the Carborex people."

"If you mean flash, viscosity and fire, it does show better, but I would suggest that you don't mix it with Carborex oil."

"Does it come up to our specifications? That's all I want to know," Phillips asked testily.

"Yes," Caldwell replied, "but I still say it's not a good idea to mix it with Carborex oil."

The independent refinery couldn't supply but a small percentage of the fuel oil required by the S. P. & W. They continued to buy most of the oil from Carborex Company with occasional cars from the independent. Disregarding the chemist's advice, fuel oil was dumped into storage tanks indiscriminately as received. Sometimes there was a complete tank of oil from one or other of the two companies, but usually the oil was mixed in varying proportions.

When the first oil was received from the independent company, the fuel supervisor observed closely to see what happened. He rode an engine that started out with a tank full of the new oil. The oil seemed to burn nicely and the fireman had very little trouble keeping steam. It showed a tendency to form more carbon than usual, but Phillips laid that to the way the burner was adjusted.

SIXTY days passed without any unusual trouble and Phillips forgot all about what his assistant had said when he tested the oil. Then one day a fast freight stopped at Middleton to take oil and couldn't get any. The oil wouldn't run. They lost an hour trying to take oil and finally set out half the train and started to Sanford. The Sanford goat met the train seven miles out and brought it in.

A water service man was sent post-haste to locate the trouble with the fuel oil at Middleton and correct the trouble. He reported that there was sediment in the tank deep enough to clog the inlet pipe of the centrifugal pump used to pump the oil to the oil crane. He raised the pump six inches and reported the station O. K. for service. Two weeks later there was a similar occurrence at Sanford.

In the meantime, Jim Evans was having some troubles of his own. Almost every engine that came in had almost as much oil on top of the tank as it did inside. The enginemen complained that the tops of the tanks weren't properly cleaned.

The master mechanic wrote a couple of hot letters about the condition and also began to watch. He was at the roundhouse when the 5082 came in looking like the tender had been dunked in a vat of hot oil. Evans was with him at the time.

The two men stood looking at the mess. "Did that engine go out like that?" the master mechanic asked.

"No," Evans replied. "It was fairly clean and it's going to take all of the laborers I've got eight hours to get it clean again. Chances are all of the paint will come off with the oil when we clean the sides of the tank," Evans added.

"This has gone about far enough," the master mechanic snapped. "And, I'm going to find out what is causing it, and stop it. I believe the truth of the matter is the firemen are getting the oil too hot and boiling it over."

Before the official had time to locate the correct the cause of the condition, however, the superintendent got in on it, and things happened fast. The Limited pulled into the station at Plainville. The superintendent didn't notice the oil on the engine tank, but he did notice the black mess splotched all over windows and sides of the passenger cars. He immediately sent for the engineer and fireman that came in on the engine pulling the Limited.

"How in the world did you manage to scatter oil from one end of the train to the other?" the superintendent asked the engineer and fireman.

The two stood uneasily looking at each other. Finally the engineer said, "The tank boiled over and the wind was blowing just right when it happened, and we were making pretty good time."

"There's no excuse for getting oil so hot it boils over," the superintendent said. "I'm going to take you both out of service pending an investigation."

"But the oil wasn't so very hot," the fireman said. "Of course it boiled over, anybody can see that, but it wasn't very hot."

"I'll have the investigation in the morning at eight o'clock," the superintendent said. "You are not due to get out until tomorrow afternoon, are you?" He picked up a letter and the men walked out.

After the enginemen had left, the superintendent called the fuel supervisor and asked him to come to the office.

"I want you to come to an investigation in the morning at eight o'clock," the superintendent said, "and if you can, explain why the epidemic of fuel oil trouble we are having."

Phillips left the office without saying anything. He didn't know just what to say. There was a haunting memory of what Martin Caldwell had said about not mixing oil from the independent company with that from the Carborex, but he couldn't for the life of him connect up that with the present trouble. He went to his office and sat nearly an hour trying to figure out what to do. Suddenly he jumped up and went into Caldwell's office, something that he seldom did.

"We've been having a lot of trouble with fuel oil lately," Phillips said, "and the superintendent wants to know the reason." Phillips paused for an answer, but all he got was, "Yes, sir."

"It's that damned oil from the Carborex Company and that's what I'm going to tell the superintendent!" Phillips sputtered.

Martin didn't say anything.

"You didn't like it when I made the deal to get oil from another company, yet you said yourself oil from the independent company showed a better test than Carborex."

"I said they shouldn't be mixed," the chemist replied.

"You might come down to the superintendent's office in the morning and see if you can explain what mixing the oils has to do with tanks filling up with sediment, oil boiling over, and other troubles we are having." Phillips strode out of the room.

"I'll be there," Caldwell said, and if Phillips hadn't been so busy nursing the huff he had, he would have detected a note of elation in Martin's voice.

NEXT morning at eight o'clock the two enginemen and a representative from their brotherhood were in the superintendent's office. The master mechanic heard of the investigation and he was there also. Phillips came in a few minutes after eight. Caldwell hadn't showed up.

Just as the superintendent started to ask the usual preliminary questions, Martin Caldwell came in carrying a large case something like enginemen use.

"Leaving?" Phillips asked in a tone that wasn't entirely joking.

"Maybe," Martin replied as he set the heavy case down carefully.

"What have you got there?" the superintendent asked.

"Mr. Phillips said you wanted to know what caused the oil to foam."

"Can you tell us?" the superintendent asked.

"I believe I can show you," Martin said mildly.

"Well, in that case, with these gentlemen's consent, I'll postpone the investigation until you show us the cause of the trouble." The superintendent indicated the engineer and fireman.

"Go ahead," the representative said.

Caldwell somewhat nervously began to unpack a formidable array of containers, thermometers, and other paraphernalia, including three alcohol lamps. As he worked, his nervousness disappeared.

"We've been getting oil from two different companies," he began. "One of these oils is cracked oil, the other is not."

"He is," Phillips whispered to the master mechanic loud enough for all to hear.

"Will you explain the difference?" the superintendent asked.

"Yes, sir," Martin poured some oil in two glass cups. "This one is cracked oil, meaning that the gasoline, kerosene, distillate and other more volatile products have been removed by refining; the process is called cracking. This is crude or uncracked oil."

Phillips started to say something, but a look from the young chemist changed his mind and he decided to keep still a little while and await developments.

Martin placed an alcohol burner under each glass cup of oil. Then he filled another cup with a mixture of equal parts of cracked and uncracked oil.

Every one in the room watched as the three containers of oil began to heat. There was a thermometer in each cup of oil. The temperatures of each reached 100 degrees; nothing happened. It got hotter and still nothing happened. At 180 degrees all three cups of oil were giving off blue vapor but nothing else happened.

Caldwell, as unconcerned as though he were alone in the little laboratory in the office, watched the thermometers and said nothing. At 212 degrees nothing had happened.

Then Phillips broke the silence. "I thought you were going to explain what caused the oil to boil over. It's past the boiling point right now and hasn't boiled over."

"Please be patient," Caldwell said. "In the meantime, I might explain that there will be a little deposit of substance like asphalt in the cup containing the cracked oil; there will be more in the one of uncracked oil and there will be considerably more in the mixed oil."

Phillips began to squirm and wanted to get off that particular subject. He jumped on the one first mentioned. "If you'll be good enough to explain what causes boiling over."

"Yes, sir," Caldwell said civilly. "Would you please spit in one of the cups of oil?"

"Spit in it?"

"Yes, it makes no difference which one."

Phillips started to argue, but the superintendent's expression stopped him. He leaned over and spat in the cup of Carborex oil that the thermometer showed had reached 300 degrees Fahrenheit.

When Phillips spit, the oil seemed to explode. The black liquid flew all over his clothes, spattered the front of his shirt, and a few drops hit his face. One drop would have gone in the fuel supervisor's eye if it had not been for his glasses.

"What in the hell is the idea?" Phillips sputtered. "If that's your idea of a joke!"

"That's what's been causing your oil to boil over—water. Water and oil don't mix and every time oil boils over, you can bet it was caused by water."

"What's mixing the two oils got to do with it?" the master mechanic asked.

"Well," Martin said, "it will take a little time for a thorough demonstration, but maybe I can give you an idea. Mixing uncracked oil with cracked oil and heating the mixture causes more precipitation of a substance like asphalt and it is partly asphalt. That deposit filled the supply tanks. It has also coated the heater coils in the tank. It is a very good material for building roads, but is a poor conductor of heat. As a result, the heater coils insulated with this aphaltic deposit don't do a good job of heating the oil and firemen are forced to use a steam jet from the open heater; hence, water in the oil. If you care to take these three cups of oil after they are cool, you can see for yourself," Martin said to Phillips.

"No, thanks, I'll take your word for it."

"There won't be any investigation," the superintendent said. "Sorry to have bothered you men." Then to Martin: "Thanks for your entertaining exhibition, but I'm wondering why you didn't say something about all of this sooner."

"Well," Martin again showed symptoms of nervousness, "the trouble came on so gradually that it kinda slipped up on us."

Phillips took such a deep breath it made him cough.

Unit Truck and Brake Beam

(*Continued from page 286*)

A. A. R. truck and brake beams were made at Johnstown, Pa., in August, 1939, under the supervision of the A. A. R. The single car break-away test was used under identical conditions. The tests were made at speeds of 10 to 50 m. p. h. with service brake applications of 10 and 22 lb. per sq. in. brake-cylinder pressure and at full emergency applications with the result that the Unit truck produced a 5.9-per cent higher brake-rigging efficiency. It was found that this truck was particularly efficient in the higher range of speeds and that the Unit brake produced 11 per cent more shoe bearing than the conventional type.

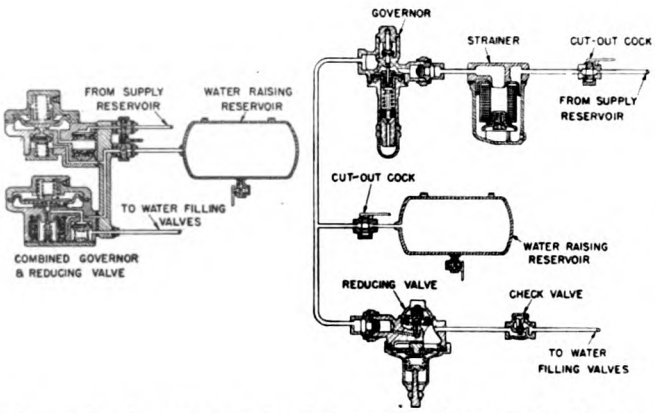
In switching service after 2,500,000 brake applications the brake beam of a Unit truck showed negligible wear. One of these trucks under an auxiliary water car after 130,000 miles in high-speed service showed 0.03-in. wear on the brake-beam wear plate and 0.02 in. on the side-frame wear plate. No measurable wear was found after 400,000 miles in refrigerator-car service and after 25,000 miles under tank and chemical cars.

Service tests indicate that these trucks will not only increase the braking efficiency, but will greatly prolong the life of the car wheels as the toggle action of the

hanger type of brakes is absent in this guided brake beam. It thus tends to eliminate brake-skid spots on the wheels. A further indication of the efficiency of this type of brake is that in 800,000 miles, all brake shoes were reported to be wearing full and even and none had been found broken. This equipment is made by the Unit Truck Corporation, New York.

Combined Governor And Reducing Valve

The Westinghouse Air Brake Company, Pittsburgh, Pa., has developed a combined governor and reducing valve for water-raising systems. It has the same functions as the present arrangement of separate devices, but is simpler to install and less expensive to maintain. The



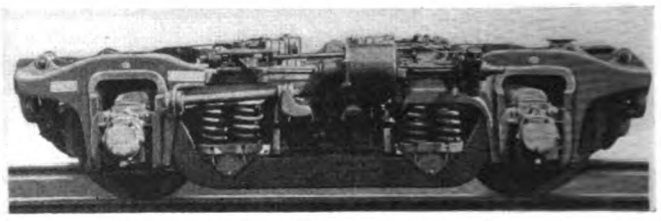
The combined governor and reducing valve shown at the left performs the same functions as the old standard arrangement of separate devices for the water-raising system shown at the right

two valve portions are assembled on a common bracket which makes this arrangement more compact, conserves installation space and permits the removal of operating parts for inspection, cleaning and testing without disturbing pipe connections. To facilitate installation and minimize air leakage, flange unions are furnished.

Two cut-out cocks, operated simultaneously by a single handle, are attached to the pipe bracket which allows for the removal of portions without first exhausting the air from the water-raising system. The operating pressure of each valve is permanently set before shipment, thereby insuring against any change in adjustment in service. Protective air strainers of curled hair and felt are installed in the inlet passages and the spring-chamber vent ports have wasp excluders. Two Wabco non-return check valves in series, one in the governor and one in the reducing valve, prevent the back flow of water to the air-brake system.

Four-Wheel Truck for Passenger Cars

A lightweight passenger-car truck of the four-wheel single drop-equalizer type has been designed and equipped by the General Steel Castings Corporation, Eddystone, Pa., to produce improved riding conditions. It has coil springs in both the equalizer and bolster positions and is furnished with shock absorbers and bolster anchors. The use of coil springs throughout



The Commonwealth four-wheel truck

eliminates the inter-leaf friction present in the usual type of elliptic bolster springs, allows for ample spring deflection, and thereby improves the riding qualities.

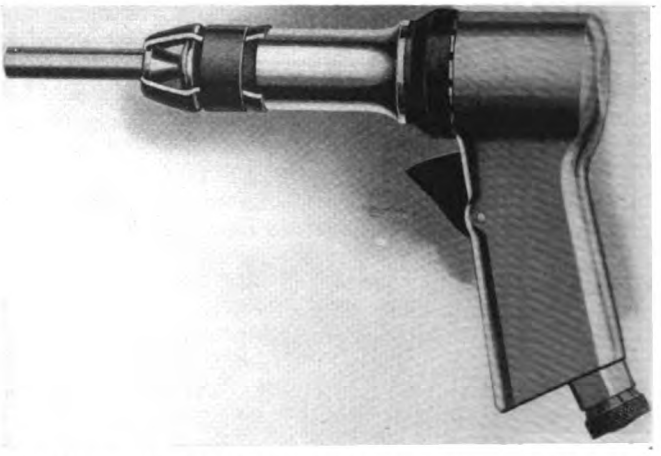
The increased spring action is controlled by one-way shock absorbers mounted at each end of the bolster. Positive cushioning and a reduction in noise is obtained, wherever practical, by the use of insulation which minimizes the metal-to-metal contact of the working parts of the truck. The bolster anchor arrangement replaces the conventional bolster and truck-frame chafing plates. It is applied on each side of the truck, being supported at one end by an integral bracket on the truck frame, the other end being attached to an integral bracket located on the extended end of the bolster. This maintains the bolster in its proper position and eliminates the wear on the chafing plates and the objectionable pounding between the bolster and frame.

Light weight with the necessary strength is made possible by the use of low-carbon nickel-alloy steel for the truck frame and bolster. Trucks of this design are in service under many cars in lightweight streamline trains where smooth riding with freedom from vibration and lateral sway is demanded.

Air-Operated Riveting Hammer

A lightweight air-operated riveting hammer for use in the fabrication of iron, steel, and aluminum products has been announced by the Ingersoll-Rand Company, Phillipsburg, N. J. It is known as Model AV and is available in two types. One is a short-stroke fast-hitting model for ordinary use, and the other is a long-stroke slow-hitting hammer designed primarily for aluminum, dural or soft iron rivets. Both are available with either a pistol grip, an offset, or a push-button handle.

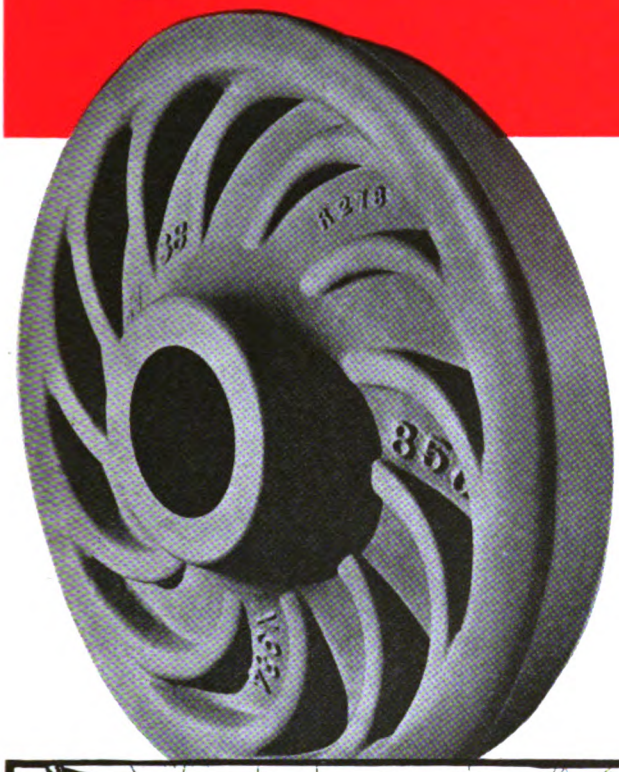
They can be adapted for very light chipping, scaling, and calking work when equipped with the proper chisel.



The Ingersoll-Rand AV-12 slow hitting hammer with offset handle

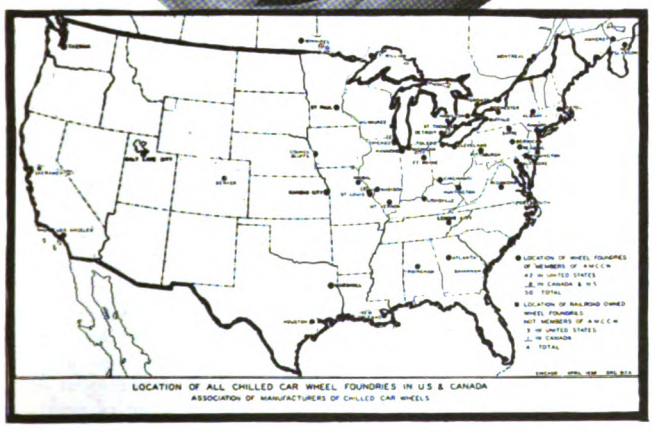
(Turn to next left-hand page)

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Railway Affairs . . .

Over Roosevelt's Veto

President Roosevelt, during his first campaign for the Presidency and several times since, has indicated that the railroads should be given remedial legislation and, yet, now that he is nearing the end of his second term, the Administration has little constructive railroad legislation to its credit. One small piece of such legislation, however, has just been put through *over his veto*—the so-called bridge bill. It relieves the railroads of the cost of rebuilding bridges required to be altered in connection with waterway projects. The vote in the Senate was 65 to 17 and in the House 324 to 68. Even Representative Culkin of New York, a waterway advocate, supported the bill. Said he, "I am glad at this time to be able to say a positive word in behalf of the railroads. I think their rights are definitely and unfairly invaded under the present law and this legislation offers a positive cure in the situation."

Rewards for Safety Performance

The E. H. Harriman Memorial Medals have been awarded under the auspices of the American Museum of Safety to those Class 1 railroads having the best safety records for the year 1939. The South-Central district of the Union Pacific was awarded the gold medal in Group A—those roads operating 10 million or more locomotive-miles per year. The Chicago, St. Paul, Minneapolis & Omaha was given the silver medal in Group B, which includes those railroads operating from one to 10 million locomotive-miles a year. The Charleston & Western Carolina was the winner of the bronze medal in Group C, those roads operating less than one million locomotive-miles a year. A special safety award was made to the New York Central System for having operated more than 16 consecutive years without a passenger fatality in a train accident, with a total of 50,463,685,000 passenger-miles. Samuel O. Dunn, editor of the Railway Age, pointed out that the great increase of railway safety since the beginning of the century has been due to improvement of railway operating rules and methods and to the improvement of railway plants, but principally to educating employees and securing their co-operation. "A great majority of railway and all other accidents," said Mr. Dunn, "always were and still are due not to shortcomings of rules or plants, but to man-failures, and the great achievement of railway managements and employees has been that of getting railway personnel to observe constantly in all its many kinds of work, the fundamental rule of safety first."

Trucking Tonnage Up

May was a record-breaking month for motor truck transportation. Reports made by the American Trucking Associations covering 184 motor carriers in 37 states and the District of Columbia, show that the May volume was 5.3 per cent above that for April and 12 per cent above that for May, 1939. Car loading reports for the month of May showed that railroad traffic was 15 per cent ahead of the same month last year.

S. 2009

The railroad brotherhoods having sabotaged the Omnibus Transportation Bill S. 2009 and sent it back to conference, Congress shows no disposition to go out of its way to pass a bill at this session—a session, by the way, which would have ended before this had it not been for developments abroad and the pressing need for national defense legislation. Railroad labor, or rather, the leaders of the railway unions, insist upon a retention of something of the Harrington "labor-protection" amendment. With all the political excitement of a presidential election year there is little possibility of getting it out of conference unless Congress continues to sit indefinitely after the Democratic convention.

Railroads at the New York World's Fair

The railroad exhibit at the New York World's Fair last year proved to be one of the most popular attractions of that great exposition. The best features of that presentation have been retained this season and a number of distinct improvements have been made, so that in its new dress it is making a still more decided impression. Edward Hungerford has supplied three new scenes for "Railroads on Parade," and with the orchestra out in front, new music and new costumes, it is going over strong. "Building the Railroad," the great mountain diorama, has likewise been changed in many respects and is much more attractively lighted. The large model railroad, which was called "Railroads at Work" last year, now goes under the title of "Railroads in Action." Its track mileage has been increased 25 per cent and it now includes 200 locomotives, as well as considerable other new special equipment. The extensive track exhibit parallels that of last year, and part of its equipment will be changed from time to time during the summer months. Visitors to the railroad exhibit are enthusiastic about the additions and improvements that have been made.

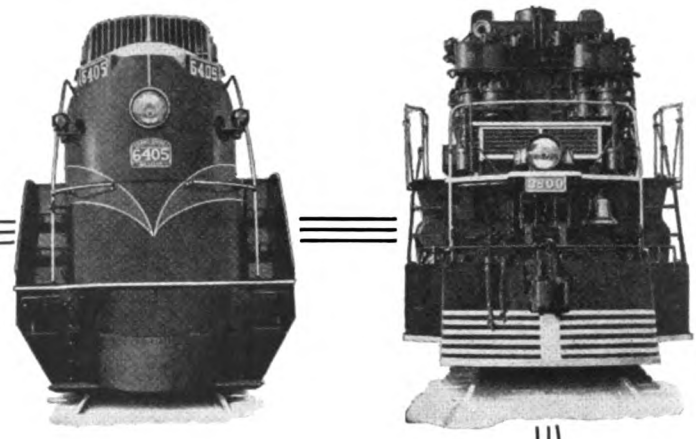
Railway Buying Up

The improvement in business on the railroads thus far this year has, as usual, been reflected in their increased purchases, according to figures recently published in the Railway Age. The total purchases for the first five months this year, including materials received from manufacturers, equipment ordered from manufacturers, and fuel, amounted to $396,303,000. This is greater than that for any corresponding period since 1930, except 1937, when these purchases amounted to 574,960,000. The figures for the first five months of this year are subject to revision, but are approximately correct. Specifically, the materials received from the manufacturers amounted to $249,064,000, the equipment ordered to $35,096,000 and fuel purchased to $112,143,000.

Railroads in Defense Program

The National Defense Commission appointed by President Roosevelt on May 28, has been assigned the task of speeding up national defense measures. As wars are conducted nowadays, industrial production is of utmost importance; indeed, it may be the decisive factor. Edward R. Stettinius, Jr., formerly chairman of the board of the United States Steel Corporation, heads up the section responsible for the supply of raw materials. W. S. Knudsen, former president of the General Motors Corporation, is responsible for industrial production. Ralph Budd, president of the Chicago, Burlington & Quincy, has the task of seeing that the materials are transported without delay. Mr. Stettinius has appointed W. A. Harriman, chairman of the board of the Union Pacific, to act as a liaison officer between the raw materials section and the transportation section. He has also appointed W. C. Bower, vice-president of the New York Central in charge of purchases and stores, to the position of purchasing agent for the raw materials section. Other members of the National Defense Commission are Sidney Hillman, president of the Amalgamated Clothing Workers of America, who will be concerned with problems of labor and employment; Chester C. Davis, a member of the board of governors of the Federal Reserve System, who will look after the farmers' interests; Harriet Elliott, dean of women at the University of North Carolina, who will study the effect of the defense measures on the consumers' interests, and Leon Henderson, a member of the Securities and Exchange Commission, who will be watchful of the effect of the production of war materials on our economy as a whole.

(*Turn to next left-hand page*)



NEW LOCOMOTIVES

should receive first consideration in the spending of the improvement dollar

because

1 **"Operating Expense" is the largest item of the railroad cost.**

2 **By hauling more tons faster, the new locomotive can produce the maximum return on the invested dollar.**

3 **New power is the key to improved service.**

To get the maximum return from your locomotive dollar . . . . POWER WITH LIMA.

LIMA LOCOMOTIVE WORKS INCORPORATED

LIMA LOCOMOTIVE WORKS INCORPORATED, LIMA, OHIO



A 19-unit train operated by the Chicago, Burlington & Quincy in connection with a recent convention of Kiwanians at Milwaukee, Wis.

NEWS

W. M. Barr Heads A. S. T. M.

At the annual meeting of the American Society for Testing Materials, held at Atlantic City, N. J., June 24-28, Dr. W. M. Barr, chief chemical and metallurgical engineer of the Union Pacific, was elected president of the Society for the ensuing year.

Burlington Operates 17 Stainless Steel Cars in Single Train

Seventeen stainless steel cars and a 4,000-hp. two-unit, stainless-steel Diesel-electric locomotive were used by the Chicago, Burlington & Quincy on June 16 to carry 500 Kiwanians from Chicago to Minneapolis, Minn., for their International convention in that city. According to the Burlington, this is the longest stainless-steel train ever operated. The train, which was operated as the second section of the Morning Twin Cities Zephyr, covered the 437 miles in seven hours. Ten of the cars comprising the train had just been delivered by the builder. The train was photographed while moving at 80 to 90 m.p.h.

Two Alco-G. E. Diesel-Electric Switchers for Stock

New Diesel-electric switchers in two sizes—660- and 1,000-hp.—based on new designs are being built for stock by the American Locomotive Company and the General Electric Company to assure quick deliveries.

Designed for an operating availability of at least 8,000 hours per year, the new units are each powered by a four-cycle Alco Diesel engine and G-E electric equipment. Better visibility and streamlining are attained by the underframe design which allows a depressed mounting of the Diesel engine, thus permitting a low narrow hood. The automatic series-parallel control installed in the switchers makes the full Diesel horsepower available for traction at all locomotive speeds up to 35 m.p.h.

One of the new Diesel-electrics is now on display at the railroad track exhibit at the New York World's Fair.

I. C. C. Authorizes Experimental Cars

The American Car and Foundry Company has been authorized by the Interstate Commerce Commission in a report by Commissioner Alldredge to construct 40 fusion-welded tank cars for service in the transportation of caustic soda solution.

The Monsanto Chemical Company and the American Car and Foundry Company have been authorized by the Interstate Commerce Commission to construct one tank car with riveted aluminum alloy tank for experimental service in the transportation of 95 per cent nitric acid. The commission's action was by Commissioner J. Monroe Johnson in another of the Special Series A orders in No. 3666.

The Union Tank Car Company has been authorized by the Interstate Commerce Commission to construct 100 fusion-welded tank cars for experimental service in the transportation of petroleum products.

Retirement Board Has New Publication

The Railroad Retirement Board has issued the first copy of its Monthly Review which will replace the Weekly Review which has been published for several months. In the foreword it is stated that the purpose of the publication is to provide current information concerning the operations under the Railroad Retirement and Railroad Unemployment Insurance Acts, primarily for employers and employees covered by those acts and for their associations and organizations.

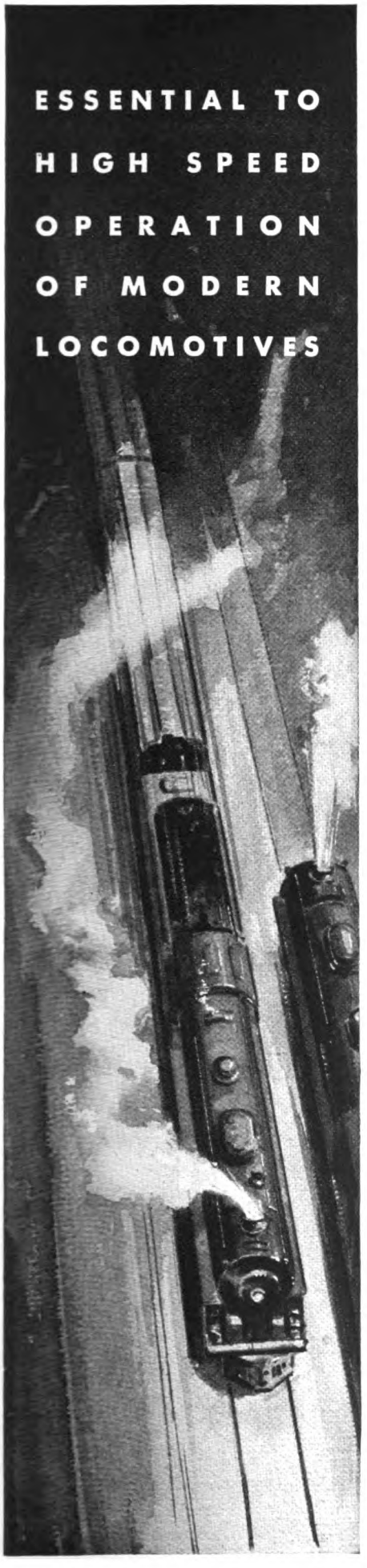
It is further pointed out that the publication will contain monthly statistics of operation under each act, explanations of the regulations and rulings made under both acts, digests of the opinions of the general counsel concerning various legal questions arising under the acts, notifications of changes in the Board's administrative organization and key personnel, special articles covering the more important phases of the operation of railroad social insurance, and other material "relevant to a better understanding of the Board's tasks and activities."

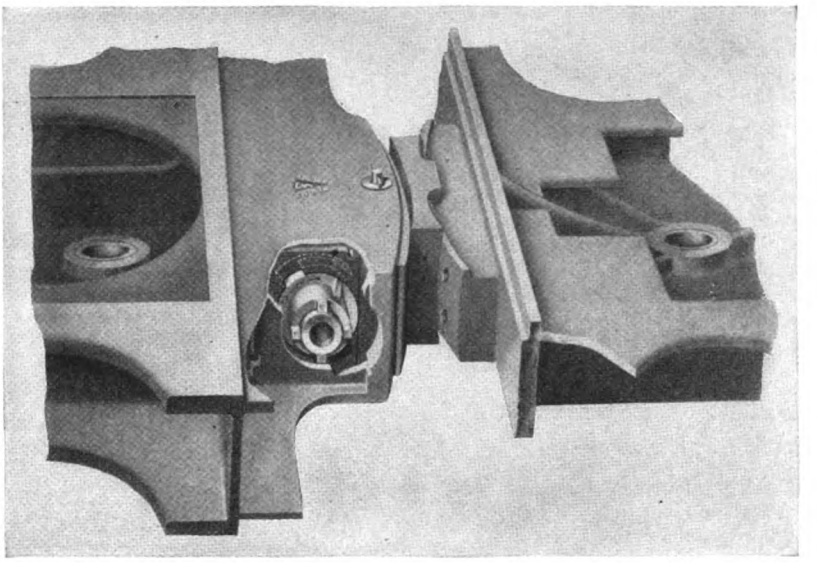
Railroads Ready for Defense Emergency, Says Pelley

At a meeting of the member roads of the Association of American Railroads at Chicago on June 18 for the purpose of discussing the equipment and transportation situation, J. J. Pelley, president, Association of American Railroads, reiterated the fact that the railroads of the United States are ready to meet any transportation demands that will arise during the evolution of our defense program or from an increase in regular commercial traffic. Ralph Budd, president of the Chicago, Burlington & Quincy, and a member of the National Defense Committee, told the same meeting that railroad management will be permitted to do its share in the national rearmament program without interference from the federal government. "The belief in Washington now is," he said, "that the railroads under private ownership and operation can do their job more effectively than if there was direct control over them. The confidence shown in the railroads by the government calls for a recognition by the

(Continued on next left-hand page)

ESSENTIAL TO HIGH SPEED OPERATION OF MODERN LOCOMOTIVES





Modern power, with long overhang over the trailing truck, must have freedom of buffer movement in every direction, and full faced contact of the buffer surfaces at all times.

It is absolutely necessary on curved track, and safer at high speeds.

Franklin E-2 Radial Buffer provides this universal movement and full contact of the buffer surfaces. It also provides high frictional resistance to compression that effectively dampens oscillation between engine and tender and eliminates lost motion and subsequent destructive shocks to drawbars and pins.

Franklin E-2 Radial Buffer effectively reduces locomotive maintenance costs and adds immeasurably to the safety of high speed operation of modern locomotives.

Franklin Compensator and Snubber, twin of the Radial Buffer, is equally essential for that other important job of protecting the foundation of the locomotive.

No locomotive device is better than the replacement part used for maintenance. Genuine Franklin repair parts assure accuracy of fit and reliability of performance.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

railroads of their own responsibility in co-operating in the defense program."

A survey submitted at the meeting showed that there were then in operation approximately 36,000 more serviceable freight cars than there were at the peak of business in October, 1939, and that by October 1 of this year there will be an increase of 148,000 serviceable freight cars over the October, 1939, figure. In October, 1939, the railroads handled a maximum of 860,000 loaded cars a week, with an average daily surplus of more than 60,000 cars.

It also showed that on June 1, 1940, the railroads had on order 15,039 new freight cars. In addition, they were ready to place orders for 3,425 more new freight cars, making a total of 18,464 cars. This is approximately twice the number on order a year ago. All these new cars, together with 13,000 other cars which are to be rebuilt this summer, will be in operation in advance of the usual fall increase in business. In addition to new and rebuilt cars, the repair program undertaken by the railroads will add not less than 80,674 serviceable cars to the supply available for meeting transportation demands this fall.

With the repair of such equipment and the addition of the new cars now on order it is estimated that the railroads will have by October 1, 1940, 147,907 more serviceable freight cars than were available at the same time last year. Of the total number of freight cars which will be in service by October 1 of this year, approximately 210,000 will be less than five years old.

Equipment Depreciation Orders

EQUIPMENT depreciation rates for thirteen railroads, including the Reading, the Detroit, Toledo & Ironton, and the Wheeling and Lake Erie, have been prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15100, Depreciation Charges of Steam Railroad Companies. The composite percentages for all equipment, which are not prescribed rates, range from 2.76 per cent for the Reading to 5.12 for the High Point, Thomasville & Denton, the higher composite figure of 10 per cent for the Union of Oregon being merely the prescribed rate for that road's locomotives other than steam, the only class of equipment covered by the sub-order applying to the Union.

The Reading's composite percentage of 2.76 is derived from prescribed rates as follows: Steam locomotives, 2.79 per cent; other locomotives, 3.84 per cent; freight-train cars—owned, 2.76 per cent, leased 2.57 per cent; passenger-train cars, 2.54 per cent; floating equipment, 2.48 per cent; work equipment, 4.6 per cent; miscellaneous equipment—owned, 10.11 per cent, leased, 5.29 per cent. The composite percentage for the D. T. & I. is 4.07, derived from prescribed rates as follows: Steam locomotives—new, 3.04 per cent, secondhand and rebuilt, 6.03 per cent; freight-train cars—new, 3.57 per cent, secondhand and rebuilt, 4.13 per cent; passenger-train cars—secondhand and rebuilt, 4.96 per cent; work equipment, 3.49 per cent; miscellaneous equipment, 17.12 per cent.

(Continued on next left-hand page)

Orders and Inquiries for New Equipment Placed Since the Closing of the June Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Locos.	Builder
Atchison, Topeka & Santa Fe	2	5,400-hp. Diesel-elec.	Electro-Motive Corp.
Chicago, Burlington & Quincy	2	1,000-hp. Diesel-elec.	Electro-Motive Corp.
	7	600-hp. Diesel-elec.	Electro-Motive Corp.
Detroit, Toledo & Ironton	4	2-8-2	Lima Loco. Wks.
E. de F. de Goyaz (Brazil)	1	4-6-0	Baldwin Loco. Wks.
Guayaquil & Quito (Ecuador)	2	2-8-0	Baldwin Loco. Wks.
Missouri Pacific	1	1,000-hp. Diesel-elec.	Electro-Motive Corp.
	1	600-hp. Diesel-elec.	Electro-Motive Corp.
	2	600-hp. Diesel-elec.	American Loco. Co.
	2	600-hp. Diesel-elec.	Baldwin Loco. Wks.
	2	44-ton Diesel-elec.	General Elec. Co.
	1	44-ton Diesel-elec.	H. K. Porter Co.
	1	44-ton Diesel-elec.	Davenport-Besler Corp.
	1	44-ton Diesel-elec.	Whitcomb Loco. Wks.
Mitsui & Co.	6	2-8-2	American Loco. Co.
United Fruit Co.	4	2-8-2	Baldwin Loco. Wks.
Western Maryland	12	4-6-6-4	Baldwin Loco. Wks.

LOCOMOTIVE INQUIRIES

Atchison, Topeka & Santa Fe	10	4-8-4	.....
Southern Pacific	20	4-8-4	.....

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Baltimore & Ohio	100	70-ton hoppers	Company shops
Cambria & Indiana	200	50-ton coal hoppers	Bethlehem Steel Co.
Central of Georgia	15	70-ton hoppers	Pullman-Std. Car Mfg. Co.
Chesapeake & Ohio	300	50-ton box	American Car & Fdry. Co.
	200	50-ton box	Gen. Amer. Trans. Corp.
	200	50-ton box	Mt. Vernon Car Mfg. Co.
	200	50-ton box	Pullman-Std. Car Mfg. Co.
	100	50-ton box	Greenville Steel Car Co.
	50	Caboose	St. Louis Car Co.
	50	Caboose	Magor Car Co.
Denver & Rio Grande Western	500[1]	50-ton box	Pressed Steel Car Co.
Detroit, Toledo & Ironton	50	70-ton hoppers	Greenville Steel Car Co.
Donora Southern	30	70-ton gondola	Magor Car Corp.
Great Northern	500	50-ton box	Pressed Steel Car Co.
	500	50-ton box	Pullman-Std. Car Mfg. Co.
Gulf, Mobile & Northern	250	50-ton hoppers	Pullman-Std. Car Mfg. Co.
	1,000[2]	Box-car bodies	American Car & Fdry. Co.
Milwaukee, St. Paul & Sault Ste. Marie	400	40-ft.-6-in. box	Pullman-Std. Car Mfg. Co.
	100	50-ton box	Pullman-Std. Car Mfg. Co.
Missouri Pacific	200[3]	40-ton steel frame stock	American Car & Fdry. Co.
	30	70-ton hoppers	Mt. Vernon Car Mfg. Co.
Mobile & Ohio	250	Hoppers	Pullman-Std. Car Mfg. Co.
New York, Chicago & St. Louis	50	70-ton gondolas	Bethlehem Steel Co.
	75	50-ton flat	Bethlehem Steel Co.
	250	50-ton gondolas	Pullman-Std. Car Mfg. Co.
	200	50-ton gondolas	Gen. Amer. Transp. Corp.
	300	50-ton box	American Car & Fdry. Co.
Tennessee Coal Iron & R. R. Co.	10	70-ton gondolas	Pullman-Std. Car Mfg. Co.
Wabash	5	Hoppers	American Car & Fdry. Co.

FREIGHT-CAR INQUIRIES

Eastern Gas & Fuel Associates	50	50-ton triple hoppers	.....
Illinois Central	1,000	40-ton box	.....
	1,000	50-ton box	.....
	500	40-ton box	.....
	500	Automobile	.....
Missouri Pacific[4]	30	70-ton hoppers	.....
Southern Pacific	1,500	Box	.....
	500	Automobile	.....

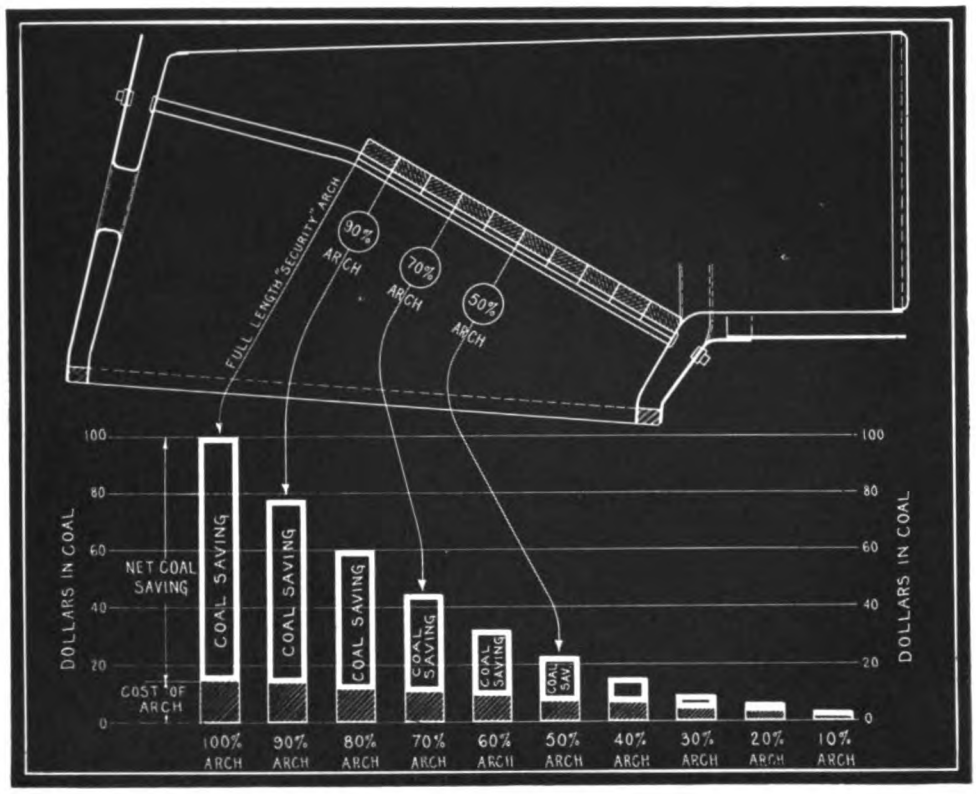
PASSENGER-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Missouri Pacific		Three-unit streamlined train[5]	.....

PASSENGER-CAR INQUIRIES

Seaboard Air Line	18	Coaches	.....
Southern Pacific	2	Bagg.-postal	(First inquiry)
	2	Baggage	(First inquiry)
	2	Artic. diner-kitchen-coffee shop (6 units)	(First inquiry)
	2	Parlor-observation	(First inquiry)
	8	Chair	(First inquiry)
	2	Artic.-chair (4 units)	(First inquiry)
	9	Bagg.-postal	(Second inquiry)
	2	Postal-storage	(Second inquiry)
	3	Postal	(Second inquiry)
	17	Baggage	(Second inquiry)
	2	Artic. counter-diner-kitchen-dormitory (4 units)	(Second inquiry)
	5	Dining	(Second inquiry)
	7	Lounge	(Second inquiry)
	50	Chair (Third inquiry)	.....

[1] Subject to approval of the court.
[2] The G. M. & N. will furnish the trucks for these cars. An order for 250 hopper cars of 50 tons' capacity was placed with the Pullman-Standard Car Manufacturing Company.
[3] One hundred for the Gulf Coast Lines; 100 for the International Great Northern.
[4] Authorized by the district court to ask for competitive bids.
[5] The 1000 hp. Diesel-electric locomotive to be built by the Electro-Motive Corporation and the two coaches by the St. Louis Car Company. The train will be operated between Memphis, Tenn., and Tallulah, La.



THE EFFECT OF ABBREVIATED ARCHES ON FUEL SAVING

LET THE ARCH HELP YOU SAVE

With the emphasis being placed on saving every railroad dollar, the locomotive Arch becomes increasingly important.

Regardless of the amount of traffic handled, the locomotive Arch saves enough fuel to pay for itself ten times over.

Be sure that every locomotive leaving the roundhouse has its Arch complete with not a single brick nor a single course missing.

In this way, you will get more work for each dollar of fuel expense. Skimping on Arch Brick results in a net loss to the railroad.

THERE'S MORE TO SECURITY ARCHES THAN JUST BRICK

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.

Locomotive Combustion Specialists

The composite percentage for the Wheeling & Lake Erie is 3.62, derived from prescribed rates as follows: Steam locomotives, 3.53 per cent; freight-train cars, 3.65 per cent; work equipment, 3.61 per cent; miscellaneous equipment, 15.65 per cent.

President Approves Changes in Titles of Inspectors

PRESIDENT Roosevelt has approved an act to amend the locomotive inspection act of February 17, 1911, so that the titles of chief inspector and assistant chief inspectors of locomotive inspection are changed to director and assistant directors of locomotive inspection, respectively.

Baldwin Has New Dispensary at Eddystone

THE Baldwin Locomotive Works has opened a new dispensary with complete equipment for the treatment of injuries resulting from industrial accidents. The dispensary occupies a six-room suite covering 1,700 sq. ft. on the first floor of the office building at the company's Eddystone, Pa., plant. A full-time doctor and registered nurse are in attendance and the dispensary will remain open under the direction of a trained nurse whenever night shifts are employed in the plant.

A novel feature of the dispensary is a dental room where the employees, if they desire, may have dental work done, paying for the service at a moderate cost. All other facilities, including emergency dental work resulting from an accident, are available without charge.

Announcing the opening of the new facilities, Charles E. Brinley, president of the Baldwin Locomotive Works, called attention to the fact that Baldwin's accident frequency last year was 28 per cent lower than in 1938 on a man-hour basis and that the severity of accidents as measured by working days lost was reduced by more than 50 per cent. "We hope," he continued, "to lower still further the number of working days lost through accidents and sickness, thus helping both the employees and the company."

I. C. C. Members Receive New Assignments

THE Interstate Commerce Commission on June 4 announced the formulation of new assignments for its members, effective on that day. On the previous day, former Assistant Secretary of Commerce J. Monroe Johnson took his oath of office as a member of the commission, succeeding Marion M. Caskie who resigned on April 1.

Under the new assignments, Division 1—Administration, will consist of Chairman Eastman and Commissioners Porter and Lee, with Commissioner Aitchison acting as an additional member "with respect to matters connected with the admission, disbarment and suspension of practitioners before the commission under Rule I-B of the Rules of Practice." Division 2—Rates, Tariffs and Valuation, will consist of Commissioners Aitchison, Splawn and Alldredge; Division 3—Rates, Service and Safety, Commissioners Mahaffie, Alldredge and Johnson, "except that Commissioner Patterson shall serve in lieu of Commissioner Alldredge with respect to matters arising under Section 26(a)-(g), inclusive, of the Interstate Commerce Act, Railroad Retirement Act of 1937, Carriers Taxing Act of 1937, Railroad Unemployment Insurance Act, the Railway Labor Act, Safety Appliance Acts, Locomotive Inspection Act, Ash Pan Act, Block Signal Resolution of June 30, 1906, Sundry Civil Appropriation Act of May 27, 1908, and Medals of Honor Act." Division 4—Finance, will consist of Commissioners Porter, Mahaffie and Miller; and Division 5—Motor Carriers, Commissioners Lee, Rogers and Patterson.

W. G. Gray Becomes Assistant Mechanical Engineer, A. A. R.

W. G. GRAY, who was appointed assistant mechanical engineer, Association of American Railroads, mechanical division, effective May 1, graduated in 1926 from Penn State College with a B.S. degree in Industrial Engineering. In September of the same year he entered railway service as a special apprentice at the Packerton, Pa., shop of the Lehigh Valley, being transferred in September, 1928, to Sayre, Pa., shop as apprentice instructor, and in September, 1929, to the mechanical engineer's office, where he worked on various design problems and analyzed road test data for both cars and locomotives. He became car foreman at the Oak Island shop in August, 1930; night foreman in the train yard at Sayre in September, 1931; assistant general foreman, passenger-car shop at Sayre in November, 1931; general supervisor, freight-passenger repairs in April, 1932, and special engineer in the office of the superintendent of motive power in June, 1937. On January 1, 1939, Mr. Gray left the service of the Lehigh



W. G. Gray

Valley to become engineer freight-car design for the Union Pacific at Omaha, Neb., a position which he held until the time of his recent appointment as assistant to W. I. Cantley, mechanical engineer, A. A. R., mechanical division.

Equipment Purchasing and Modernization Programs

Chicago, Milwaukee, St. Paul & Pacific.—The Milwaukee plans an addition and alterations to its locomotive machine and boiler shop at South Minneapolis, Minn., and also replacement of the old transfer table at that point with a new electrically-operated two-rail type transfer table of 225

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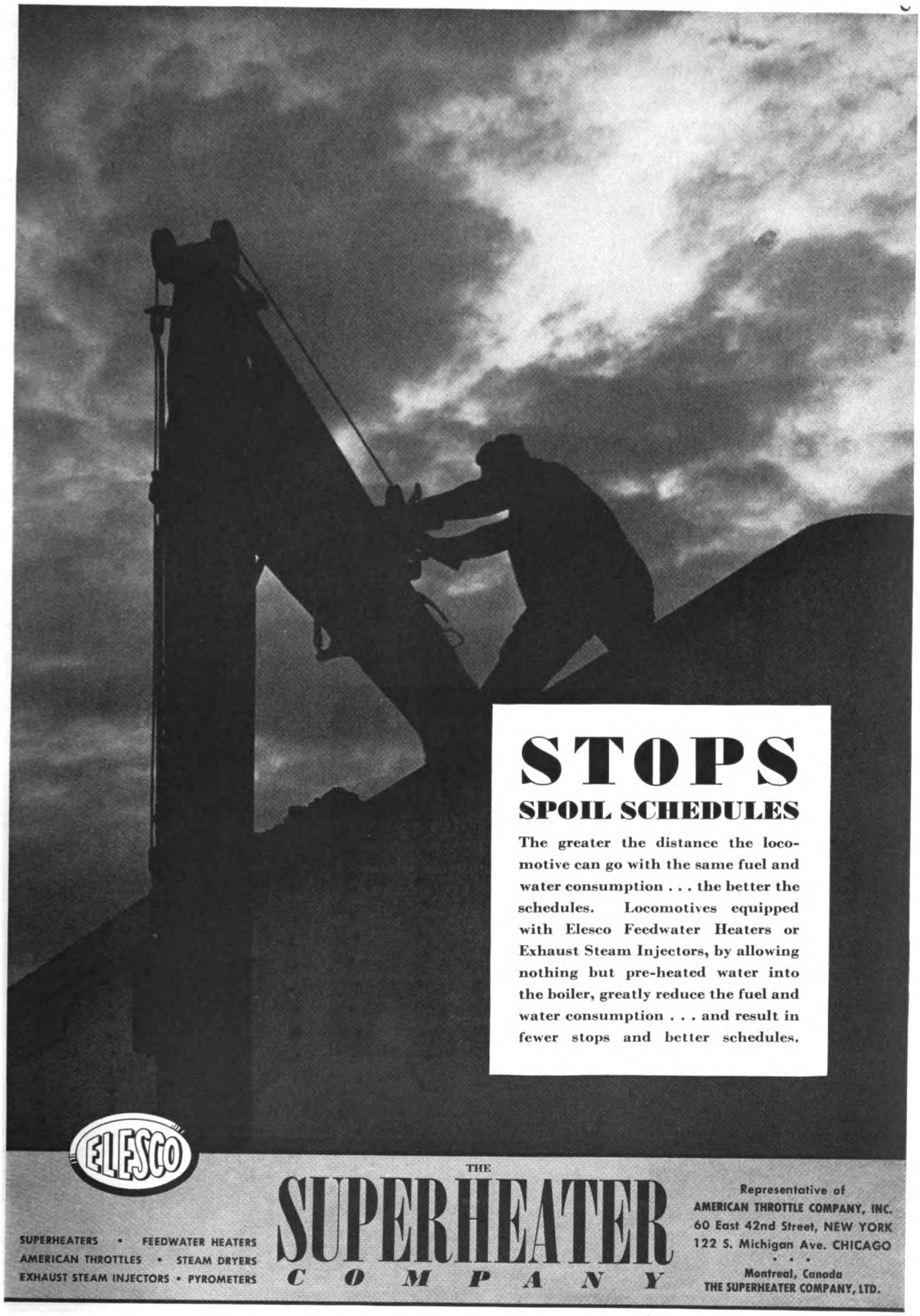
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Photo by Blakeslee-Lane

Interior of one of fourteen modern coaches recently placed in service by the Southern

The cars were modernized by the road in its own shops at a cost of approximately $275,000. They are air-conditioned and fitted, among other things, with reclining chairs, individual seat lighting, special baggage and parcel storage compartments and spacious lounges and smoking compartments


STOPS
SPOIL SCHEDULES
The greater the distance the locomotive can go with the same fuel and water consumption . . . the better the schedules. Locomotives equipped with Elesco Feedwater Heaters or Exhaust Steam Injectors, by allowing nothing but pre-heated water into the boiler, greatly reduce the fuel and water consumption . . . and result in fewer stops and better schedules.
ELESCO
SUPERHEATERS • FEEDWATER HEATERS
AMERICAN THROTTLES • STEAM DRYERS
EXHAUST STEAM INJECTORS • PYROMETERS
THE SUPERHEATER COMPANY
Representative of
AMERICAN THROTTLE COMPANY, INC.
60 East 42nd Street, NEW YORK
122 S. Michigan Ave. CHICAGO
• • •
Montreal, Canada
THE SUPERHEATER COMPANY, LTD.

tons' capacity. The addition to the locomotive machine and boiler shop will be 16 ft. wide and 198 ft. long, constructed with steel framework; corrugated, galvanized iron insulated walls and roof; wood sash and rolling steel doors. The alterations will include the construction of a new concrete drop table pit 15 ft. by 43½ ft., and 16 ft. deep, the installation of a four-screw 80-ton electrically operated drop table, and the replacement of stone masonry engine pits with six new concrete pits. The pits will be of such design that it will be possible to jack up all classes of locomotives for repair work. In addition, one track in the boiler shop will be extended through the boiler shop to connect with a track in the enginehouse to provide a through track from the transfer table to the roundhouse turntable. The total estimated cost of the improvements is nearly $113,000.

Chicago, Rock Island & Pacific.—Approximately $82,000 will be spent for the electrification of the El Reno (Okla.) terminal and the construction of a new machine shop at that point. Included in the electrification work will be the installation of electric-driven air compressors and water pumps in place of steam-driven units. The new machine shop will be constructed as an annex to the enginehouse and will be a one-story steel, brick and concrete structure 80 ft. by 120 ft. Most of the equipment to be installed in the machine shop will be transferred from other points.

Denver & Rio Grande Western.—The D. & R. G. W. has asked the Interstate Commerce Commission for authority to assume liability for $1,522,299 of four per cent equipment trust certificates, maturing in 15 equal annual installments beginning September 1, 1941. The proceeds will be used as part payment for equipment costing $1,698,110 and consisting of 500 50-ton, 40½ ft. box cars.

Great Northern.—The Great Northern's improvement and equipment program for 1940 calls for the expenditure of about $21,000,000. The largest items on the program, already under way in the 10 states in which the road operates, are for equipment, roadbed maintenance and improvement. The company announced late in 1939 plans for the purchase of new, and the reconditioning of old, equipment but expenditures for these items are included in this year's budget. The road will acquire new, and recondition old, equipment this year at a cost of about $13,000,000. This includes the purchase just made of 2,000 modern box cars at a cost of $6,000,000, the reconstruction of 10 ore service locomotives and the general reconditioning of locomotives, freight and passenger cars. An expenditure of about $570,000 has been authorized for alterations and reconstruction of freight and passenger stations, enginehouses, elevators, water tanks and coaling stations at various points along the line.

Illinois Central.—The Reconstruction Finance Corporation has agreed to loan the Illinois Central $11,000,000 for the purchase of new equipment, the rolling stock to consist of 3,000 box cars, two or three Diesel-electric trains and six Diesel-electric passenger locomotives.

Missouri Pacific.—The Missouri Pacific has asked the Interstate Commerce Commission for authority to assume liability for $750,000 of equipment trust certificates, maturing in payments of $75,000 on August 1 of each year from 1941 to 1950, inclusive. The proceeds, together with a cash payment of $190,000, will be used to purchase equipment costing a total of $940,000 and consisting of one 125-ton, 1,000-h.p. Diesel-electric switching locomotive; one 100-ton, 600-h.p. Diesel-electric switching locomotive; four 100-ton, 660-h.p. Diesel-electric switching locomotives; five 44-ton Diesel-electric switching locomotives; one 1,000-h.p. Diesel-electric passenger locomotive; one streamline train consisting of one coach-mail car and one coach-grille car of lightweight low-alloy high-tensile steel and 30 70-ton covered cement hopper cars.

The Missouri Pacific is repairing 214 box cars, lining 60 coal cars with galvanized sheet iron and converting 7 dump cars into container cars in its own shops.

Norfolk & Western.—The Norfolk & Western is proceeding with an improvement program amounting to approximately $8,000,000. This program includes the purchase of 25,000 tons of 131-lb. steel rail and fastenings; 1,000 new 55-ton hopper coal cars; 500, 40-ft. box cars, and 50, 50-ft. box cars.

Pennsylvania.—The directors of the Pennsylvania have authorized the placing of orders for new equipment, to cost approximately $10,000,000, to include the following:

1,900 general purpose "mill-type" gondola cars, 52½ ft. long, 70-ton capacity.
200 "mill type" gondola cars, 65 ft. long, 70-ton capacity.
225 covered, weather-proof hopper cars for bulk transportation of cement, etc.
200 all-steel cabooses, with insulated bodies.
20 heavy-duty flat cars of extra large carrying capacity.
25 tenders of 21,000-gal. capacity.

In addition, the board has authorized the construction of two high-speed coal-burning steam passenger locomotives of a new design, utilizing four cylinders to turn eight driving wheels; also eight ultra-modern-type passenger cars for use in the new Chicago-Miami luxury coach train service to be inaugurated next fall.

Western Maryland.—The Western Maryland has asked the Interstate Commerce Commission for authority to assume liability for $1,890,000 of two per cent equipment trust certificates, maturing in 10 equal annual installments of $189,000 each on July 15 in each of the years from 1941 to 1950, inclusive. The proceeds will represent 79.92 per cent of the purchase price of equipment costing $2,364,720 and consisting of 12 new standard gauge single expansion articulated 4-6-6-4 simple mallet steam locomotives.

Virginian.—The Virginian has received prices for materials to be used in the construction of 500 hopper cars of 50 tons' capacity; these cars may be built in its own shops.

Supply Trade Notes

ROBERT L. CLAUSE, vice-president of the Pittsburgh Plate Glass Company, has been promoted to the newly created position of executive vice-president.

◆

MANNING, MAXWELL & MOORE, INC.—The name of the Ashcroft American Gauge Division has been changed to Ashcroft Gauge Division.

◆

ARTHUR T. COX has been appointed sales manager of the Bettendorf Company, with headquarters at Bettendorf, Ia. Heretofore Mr. Cox has been district manager of the Lincoln Electric Company.

◆

FRED L LAWRENCE has been appointed Detroit district manager, with office in the General Motors building, Detroit, Mich., for the Copperweld Steel Company, Glassport, Pa.

E. H. ANCHORS, branch manager for the Air Reduction Sales Company at Atlanta, Ga., has been appointed manager of the Oklahoma City, Okla., district.

◆

THE BRAKE EQUIPMENT & SUPPLY COMPANY, Chicago, will move into a new plant at 7001 West Sixty-Sixth Place in the Clearing industrial district on June 1. The new plant contains 25,000 sq. ft. of floor space.

◆

W. C. MORGENSTERN has been appointed assistant chief engineer of the Copperweld Steel Company, with headquarters in the company's new plant at Warren, Ohio.

◆

MARSHALL D. RAYMOND, district sales manager of the American Locomotive Company, New York, with headquarters at San Francisco, Cal., has been transferred to Cleveland, Ohio, and has been succeeded by Stephen G. Harwood, formerly representative at Chicago.

◆

THE RYAN DEVICES COMPANY, Chicago, has moved its offices to 332 South Michigan boulevard.

◆

ALLEN W. MORTON, vice-president of the Koppers Company, in charge of the American Hammered Piston Ring Division, has been granted a leave of absence to serve as a full-time special assistant to Edward R. Stettinius, Jr., chairman of the Advisory Commission to the Council of National Defense.

◆

TRUMAN B. BROWN, who has been employed in the development and sales promotional activities of Ludlite for the Allegheny Ludlum Steel Corporation, Pitts-

burgh, Pa., has been promoted to manager of Ludlite sales, with headquarters at Watervliet, N. Y.

◆

C. R. MITCHELL, JR., has been appointed assistant district manager of sales for the New York district office of the Allegheny Ludlum Steel Corporation, Pittsburgh, Pa.

◆

MAX F. BECKER has been appointed vice-president in charge of sales representatives of the Whiting Corporation, Harvey, Ill. After his graduation from Purdue University in June, 1920, he began



M. F. Becker

work in the pulverizer division of the Whiting Corporation. Mr. Becker for several years served in various departments and then became manager of the Whiting foundry equipment division. In 1939 he was appointed sales manager of the industrial division, which position he held at the time of his appointment as vice-president.

◆

ELASTIC STOP NUT CORPORATION has moved its general office from Elizabeth, N. J., to its new plant at 2332 Vauxhall Road, Union, N. J., a suburb of Newark. The corporation's Houston, Tex., office has been moved to The Merchants and Manufacturers building.

◆

J. R. KUMER, JR., assistant manager of sales, stainless bar and wire products, for the Allegheny Ludlum Steel Corporation, Pittsburgh, Pa., has been appointed manager of stainless bar and wire sales succeeding C. B. Boyne. Louis F. Lippert of the sales division has been appointed manager of Pluramelt sales with headquarters at Pittsburgh.

◆

JOHN W. ALDEN has been appointed mill metallurgist for the steel and tube division of the Timken Roller Bearing Company. Mr. Alden was employed as metallurgist for the United Steel Company, the Central Alloy Steel Corporation, and Republic Steel Corporation before becoming a member of the staff of the Timken Roller Bearing Co.

◆

THE AIR REDUCTION COMPANY has completed the construction of an acetylene plant at West Berkeley, Cal. The new plant is located just a short distance from the site of the old plant, and includes all modern equipment for the manufacture of acetylene and the filling, compressing and the handling of cylinders.

◆

C. R. HALL, assistant purchasing agent since 1936 of the Air Reduction Company, has been appointed purchasing agent of the company and its subsidiary and affiliated concerns, succeeding H. M. Daggett, retired.

◆

THE KOPPERS COAL COMPANY on June 1 moved its Philadelphia, Pa., district office from the Packard building to 1458 Broad Street Station building, and The Wood Preserving Corporation at that address has moved its office to the same suite. The Koppers Coal Company is an affiliate and The Wood Preserving Corporation is a subsidiary of the Koppers Company.

◆

GLOBE STEEL TUBES COMPANY.—*Frank T. Murphy* has been appointed manager of sales of the St. Louis district. *Neal E. Boeckler* has been appointed assistant manager of sales of the St. Louis district. *Gilbert H. Krohn*, manager of sales of the Wisconsin district, has been transferred to Chicago as sales agent, and *Charles A. Schroeder* has been appointed manager of sales of the Wisconsin district, with headquarters at Milwaukee, Wis.

◆

UNITED STATES STEEL CORPORATION.—*Edward R. Stettinius, Jr.*, has resigned as chairman of the board of directors and as a member of the board of directors and finance committee of the United States Steel Corporation in order to serve as a member of the recently appointed National Defense Commission. *Irving S. Olds* has been elected chairman of the board of directors to succeed Mr. Stettinius. *Irving Sands Olds*, who has been a member of



Irving S. Olds

the finance committee of the Steel Corporation since October 27, 1936, was born at Erie, Pa., on January 22, 1887. He was a graduate from Erie High School in 1903, from Yale College in 1907, and Harvard Law School in 1910. He was admitted to the bar in Pennsylvania in 1910 and in New York in 1912. Mr. Olds was secretary to Justice Holmes, of the United States Supreme Court, 1910-1911, becoming connected with White & Case, a New York legal firm, in August, 1911, and admitted as a partner January 1, 1917. During 1917-1919 he served as counsel for the purchasing department of the British War Mission to the United States, and in 1918 was a special assistant in the U. S. War Department. Since 1919, Mr. Olds, as a member of the firm of White & Case, has engaged in legal work related to matters of organization and administration of corporate business enterprises.

◆

GEORGE D. CASGRAIN, vice-president of the Griffin Wheel Company, Chicago, retired from active service on July 1, and has been elected vice-president of the Marquette Railway Supply Company, Chicago. Mr. Casgrain was born in Milwaukee, Wis.,



George D. Casgrain

and was employed by the Griffin Wheel Company for 40 years. His activities have been devoted to sales matters in addition to which he has had supervision over all purchases since 1932. From 1890 to 1895, he was employed by the Fitzsimmons & Connell Company, contractors and timber dealers, and from 1895 to 1900, he worked in the contract department of the Chicago Telephone Company. In January of the latter year, Mr. Casgrain resigned to become associated with the Griffin Wheel Company.

Obituary

WALTER C. DOERING, vice-president of the American Steel Foundries, Chicago, at St. Louis, Mo., died in that city on June 20. For a number of years Mr. Doering was vice-president of the Bradford Corporation, and in 1930 resigned to become vice-president of the American Steel Foundries at St. Louis.

◆

GEORGE LEWIS BOURNE, chairman of the board of The Superheater Company, who died on May 25 at his home in Larchmont, N. Y., at the age of 67, was born in London, Eng., in 1874. After a period of preparatory school study at Rugby, he emigrated to Canada where he was employed by the Hudson's Bay Company and the Canadian Pacific. In 1893, Mr. Bourne

(*Continued on second left-hand page*)

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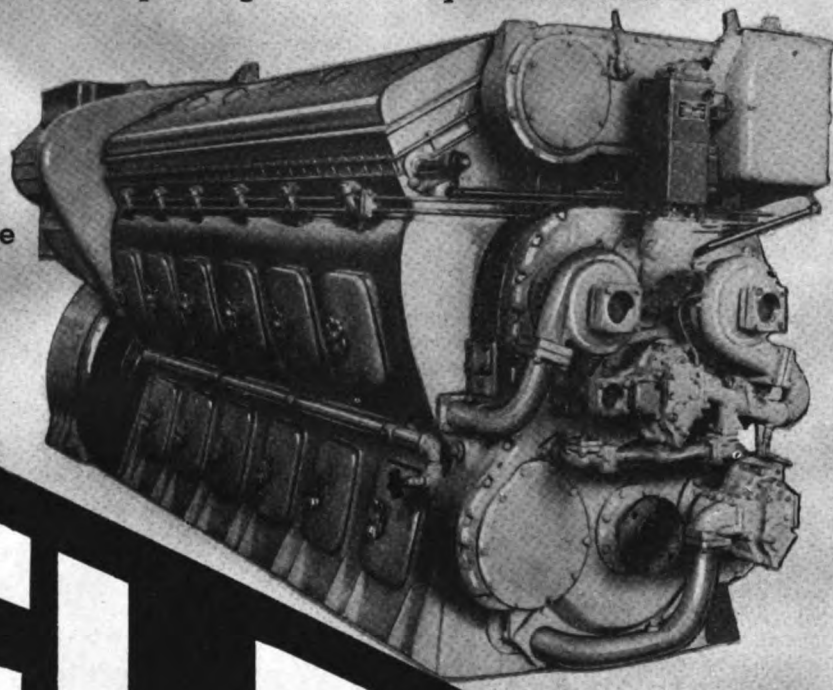


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2-Cycle Diesel Engine

IESEL POWER



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CORPORATION

LA GRANGE, ILLINOIS, U. S. A.

came to the United States and for the next decade held various jobs, chiefly as fireman and locomotive engineer, on a number of western roads, including the Northern Pacific and the Chicago Great Western. On the latter he served for a time under Walter P. Chrysler, the automobile manufacturer, then master mechanic at Oelwein, Ia. Leaving railroad service, Mr. Bourne for a short time taught air-brake practice at the International Correspondence Schools, Scranton, Pa., after which he entered the railway supply field as a salesman, including service as vice-president of the Railway Materials Company, Chicago, between 1904 and 1910. During this period, Mr. Bourne had occasion to frequent most of the railroad shops in the country while selling such products as the Ferguson oil furnace and made an extensive study of motive-power problems. At this time he became interested in the design and manufacture of superheaters for locomotives which were being developed by the German Dr. Wilhelm Schmidt, Messrs. Vaughan and Horsey in Canada and others. In 1910, he joined S. G. Allen and the late J. S. Coffin in incorporating the Locomotive Superheater Company which took over scattered patents for superheating equipment and established manufacture on a large scale. He himself became vice-president, and in 1915, president. In 1916, he joined with G. M. Basford, Messrs. Allen and Coffin and others in forming the Locomotive Feed Water Heater Company, which The Superheater Company later absorbed. In 1932, Mr. Bourne was elected chairman of the board of The Superheater Company and was succeeded as president by Frederic A. Schaff. The following year, Superheater purchased a controlling interest in the International Combustion Engineering Corporation and affiliates, designers and manufacturers of a complete line of boilers and fuel-burning and related equipment, and The Air Preheater Corporation. Mr. Bourne became chairman of the re-organized Combustion Engineering Company, Inc. Mr. Bourne was a member of a large number of social and professional organizations, including the Western Railway, New York Railroad and Central Railway Clubs, the Newcomen



George L. Bourne

Society and the American Society of Mechanical Engineers.

Personal Mention

General

A. R. RUITER, assistant to the chief operating officer of the Chicago, Rock Island & Pacific, at Chicago, has been appointed superintendent of motive power of the First Mechanical district, with the same headquarters, succeeding G. P. Trachta.

WALTER BOHNSTENGEL, assistant engineer of tests on the Atchison, Topeka & Santa Fe, has been promoted to engineer of tests for the system, with headquarters as before at Topeka, Kan., succeeding to a portion of the duties of E. E. Chapman, mechanical assistant at Chicago, who has been serving also as engineer of tests.

GERALD P. TRACHTA, superintendent of motive power on the Chicago, Rock Island & Pacific at Chicago, has been promoted to assistant chief operating officer-mechanical, a newly created position, with the same headquarters and with jurisdiction over the mechanical department and all matters pertaining thereto. Mr. Trachta was born at Schuyler, Neb., on October 5, 1883, and entered railway service on December 19, 1901, as an enginehouse sweeper on the Chicago, Burlington & Quincy at Sheridan, Wyo., later becoming machinist helper and machinist. He entered engine service on March 10, 1903, as a locomotive fireman, being advanced to locomotive engineer on October 5, 1905, and to road foreman of engines on the Sheridan division on October 1, 1910. Seven years later he was promoted to the position of master mechanic on the Casper division, resigning on December 1, 1919, to become road foreman of engines on the Arizona Eastern (now part of the Southern Pacific), at Phoenix, Ariz. On March 1, 1923, Mr. Trachta returned to the Burlington as enginehouse foreman at Wymore, Neb., being promoted to general foreman at Kansas City, Mo., on August 1, 1923, and to master mechanic at Omaha, Neb., on August 1, 1925. Subsequently he was transferred to Galesburg, Ill., and thence to St. Joseph, Mo. On March 1, 1937, he was appointed district



Gerald P. Trachta

superintendent of motive power on the Chicago, Rock Island & Pacific, with headquarters at Kansas City, Mo., and in the latter part of 1938, was transferred to Chicago.

Master Mechanics and Road Foreman

G. M. LAWLER, who has been appointed division master mechanic of the Atchison, Topeka & Santa Fe at LaJunta, Colo., with jurisdiction over the enginehouse, locomotive and car departments, was born on July 12, 1888, at Albuquerque, N. M. He entered the service of the Santa Fe on March 1, 1905, as a machinist apprentice at Albuquerque. He became a machinist on May 10, 1909; gang foreman on November 24, 1910, and enginehouse foreman on February 20, 1912. He was transferred to Belen, N. M., as division foreman on November 1, 1915; to Raton, N. M., as general enginehouse foreman on January 11, 1917; to LaJunta as master mechanic, River Division, on November 1, 1920, and to Dodge City, Kan., as master mechanic on April 1, 1930. He became master mechanic of the Colorado & Western, with jurisdiction over the shop and car departments, on May 15, 1940.

C. T. FORSTER, general foreman of the Chicago & Western Indiana, has been appointed master mechanic, with headquarters as before at Chicago.

GEORGE SANDERS, general foreman, mechanical department of the Union Railroad, has been appointed master mechanic, with headquarters at East Pittsburgh, Pa.

JACOB UHRIG has been appointed master mechanic in charge of the locomotive and car departments of the Belt Railway Company of Chicago, succeeding P. Baker.

P. D. HAWKINS, assistant district fuel supervisor of the Erie at Marion, Ohio, has been appointed road foreman of engines of the Mahoning division with headquarters at Cleveland, Ohio.

CHARLES ALEXANDER WILSON, who has been appointed master mechanic of the middle division of the Pennsylvania, with headquarters at East Altoona, Pa., as noted in the June issue of the *Railway Mechanical Engineer*, was born on September 29,

1885, at North East, Md. He attended Perryville Public School; Jacob Tome Institute, Port Deposit, Md., and Drexel Institute. He became employed as a machinist apprentice in the Maryland division shops of the Pennsylvania at Wilmington, Del., on June 8, 1903. Upon the completion of his apprenticeship he served as a machinist until 1909; as a gang foreman, electrical department, until 1911; as foreman, electrical department, until 1917; as electrical supervisor, W. J. & S. R. R., until 1918; as assistant master mechanic, W. J. & S. R. R., until 1923; and assistant master mechanic of the Trenton



C. A. Wilson

division of the Pennsylvania, until 1925. From 1925 to 1929, Mr. Wilson was master mechanic of the Tyrone and Cresson division; from 1929 to 1933, master mechanic of the Atlantic division, and from 1933 to 1937, master mechanic of the Pennsylvania & Reading Seashore Line. He became master mechanic of the Williamsport division of the Pennsylvania, on April 16, 1937.

HAROLD C. WRIGHT, who has been appointed master mechanic of the Pennsylvania at Renovo, Pa., as announced in the June issue, was born on September 18, 1894, at Altoona, Pa. He attended Pennsylvania State College and received his B.S. degree in mechanical engineering with the class of 1919. He entered the service of the Pennsylvania as a store attendant on June 12, 1911, and was subsequently employed as clerk, December 12, 1913; store attendant, June 24, 1916; shop hand, June 6, 1917; special apprentice, July 1, 1919; inspector motive power, September 12, 1921; gang foreman, September 16, 1924; acting assistant foreman, April 17, 1926; gang foreman, April 24, 1926; foreman enginehouse, March 1, 1927; assistant foreman enginehouse, June 16, 1928; assistant master mechanic, Western Pennsylvania division, May 24, 1935; assistant engineer motive power, office general superintendent motive power, Chicago, April 16, 1937; foreman enginehouse and car shop, June 16, 1938; assistant master mechanic, Philadelphia division, July 1, 1939, and master mechanic, Altoona, May 1, 1940.

Car Department

WILLIAM H. TAYLOR, general car foreman of the Atchison, Topeka & Santa Fe at Clovis, N. M., retired on June 1.

C. L. PARNABY, gang foreman at the Lakeland shop of the Atlantic Coast Line, has been appointed assistant car foreman at Waycross, Ga., succeeding H. G. Moore.

H. G. MOORE, assistant car foreman of the Atlantic Coast Line at Waycross, Ga., has become foreman of the car department at Jacksonville, Fla.

F. J. SWANSON, general car foreman on the Chicago, Milwaukee, St. Paul & Pacific at Milwaukee, Wis., has been appointed general car department supervisor, with headquarters at Chicago, succeeding William Snell, who retired on May 29.

Shop and Enginehouse

M. T. NAIVE, assistant night boiler foreman at the Radnor (Tenn.) enginehouse of the Louisville & Nashville, has been promoted to the position of boiler foreman, succeeding Stephen Holt, retired.

ALBERT H. BAIR, pipefitter foreman on the Union Railroad at East Pittsburgh, Pa., has been promoted to the position of general foreman, mechanical department.

J. H. ARMSTRONG, general foreman of the locomotive shop of the Atchison, Topeka & Santa Fe, at Topeka, Kan., has been appointed superintendent of shops, with the same headquarters, succeeding Howard H. Stephens, who has retired.

L. A. HARTLEY has been appointed supervisor of apprentices of the Erie, with headquarters at Cleveland, Ohio, succeeding C. P. Brooks.

Obituary

GEORGE GIBBS, consulting engineer of the Pennsylvania and chief engineer of electric traction of the Long Island, with headquarters at New York, died on May 19.

CHARLES J. WYMER, who retired on July 1, 1938, as superintendent of the car department of the Chicago & Eastern Illinois, with headquarters at Danville, Ill., died at Danville on June 16, after several months' illness following a light stroke. Mr. Wymer entered railroad service in 1891 with the Atchison, Topeka & Santa Fe. He later became connected with the car inspecting department of the Chicago & Eastern Illinois, resigning as general car inspector in 1912. He was then appointed general car foreman on the Belt Railroad of Chicago. In May, 1916, he was appointed sales representative at the Chicago office of the Grip Nut Company and in September, 1919, he returned to the C. & E. I. as superintendent of the car department, with headquarters at Danville. Mr. Wymer served as president of the Master Car Builders' and Supervisors' Association in 1929-30, and as second vice-president of the Western Railway Club, Chicago, in 1932-33.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

ENDURO STEELS.—Republic Steel Corporation, Cleveland, Ohio. Four illustrated booklets descriptive, respectively, of corrosion and heat-resisting steels, Types HCN, NC-3 and HC; stainless steel, Types AA, AA-FM, S-1, and FC; stainless and heat-resisting steels, and stainless steel, 18-8 types.

◆

WORTHINGTON CENTENARY.—Worthington Pump and Machinery Corporation, Harrison, N. J. An 80-page illustrated chronological story of the development and growth of the company 1840-1940.

◆

SHAPERS.—The Cincinnati Shaper Co., Cincinnati, Ohio. Twenty-seven page catalogue N-1, covering power rapid traverse, universal, utility and high-speed Cincinnati shapers, with details of construction.

◆

LANDIS EQUIPMENT.—Landis Machine Company, Waynesboro, Pa. Folder descriptive of Landis thread-cutting die heads, thread-cutting machines and collapsible taps.

◆

ALKALINE CLEANING.—Pennsalt Cleaner Division, Pennsylvania Salt Manufacturing Company, 1000 Widener Bldg., Philadelphia, Pa. Illustrated, eight-page folder on application of alkaline cleaning to various industries, including the cleaning of floors, walls, machines, locomotives, etc.

◆

NICKEL ALLOYS. — The International Nickel Company, Inc., 67 Wall street, New York. "Seven Minutes with Seven Metals," a pocket size booklet on uses and properties of nickel, monel Inconel, and associated alloys in both mill and clad forms.

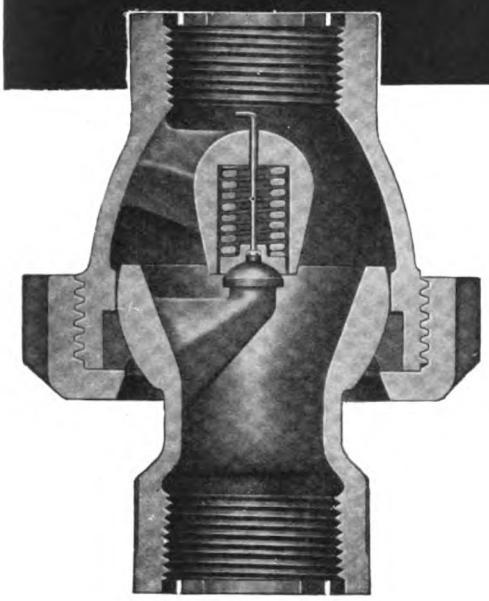
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ELECTRODES.—Wilson Welder & Metals Company, Inc., New York. "Wilson Arc-Welding Electrodes," a 24-page guide for making proper selections of electrodes for all kinds of welding work. Describes physical properties of the electrodes and suggests proper application and welding procedure.

◆

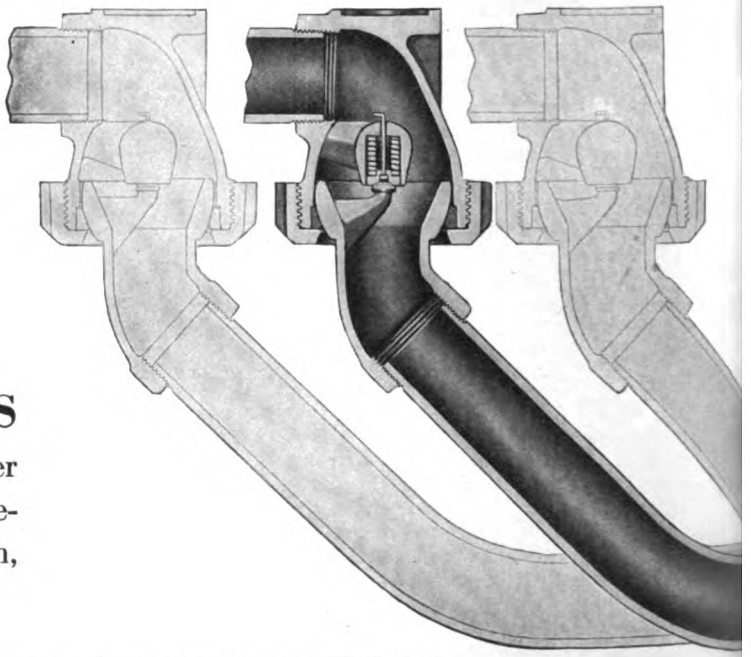
SPUN HEADS FOR BOILERS, TANKS, ETC.—Lukens Steel Company, 308 Lukens building, Coatesville, Pa. "Lukens Flanging and Pressing," a 132-page wire-bound manual for the equipment designer and fabricator. Gives essential data for flanged only heads, flanged and dished heads, elliptical dished heads, flanged and reverse dished heads, etc. Engineering data.

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See page 303

August, 1940

Volume 114 *No. 8*

Car:

N. Y. S. & W. Installs Air-Cooled Rail Cars 303
Slotted-Type Steel Running Boards 314

Locomotive:

Combating Locomotive Obsolescence 310

Editorials:

Air Conditioning—Asset or Liability? 315
Proper Car Inspection to Reduce Train Delays 315
One Form of Training for Locomotive Supervisors 316
Another Aspect of Defense Transportation 316
New Books 317

Car Foremen and Inspectors:

Lehigh Valley Converts Hopper Cars for Cement 318
Wheel Stick Designed to Eliminate Journal Damage 322
Bucking Bar for Steel Car Work 322
Air Brake Questions and Answers 322
Motor-Operated Jack for Empty Freight-Car Work 323

Backshop and Enginehouse:

Paducah Shop Jigs, Fixtures and Devices 324
Flock of Troubles (A Walt Wyre story) 327
Locomotive Boiler Questions and Answers..... 330
Locomotive and Car Cleaner 331

High Spots in Railway Affairs 332

News 333

Index to Advertisers ..... (Adv. Sec.) 36

Roy V. Wright
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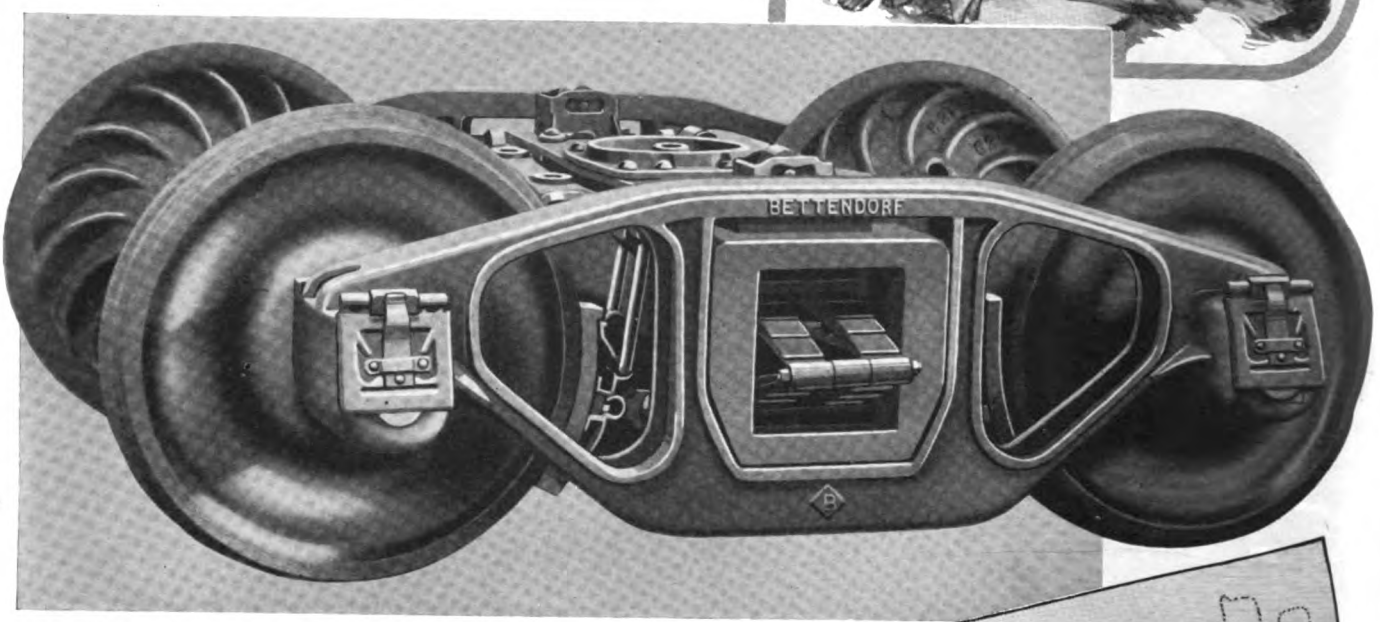
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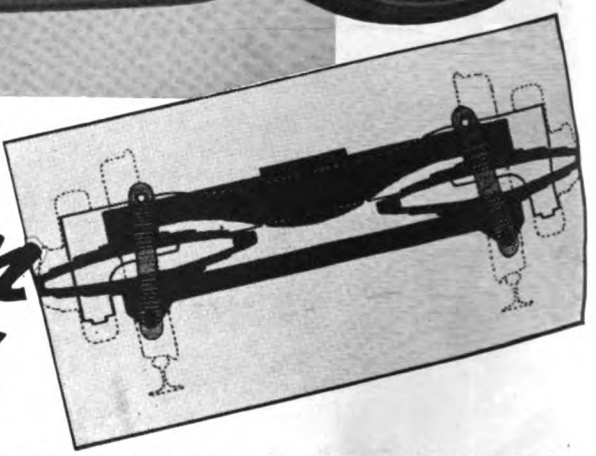
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Air-Cooled Rail Cars

Light-weight, alloy-steel, air-conditioned cars for suburban service are powered by supercharged oil engine and have hydraulic-mechanical drive

ON JULY 15 the New York, Susquehanna & Western placed two 80-passenger rail cars in commuter service between Susquehanna Transfer, N. J., Paterson and Butler. These cars operate in a service requiring a total of 50 trips a day and each car accumulates about 430 miles a day. The trips vary in length from 15.3 to 34.4 miles.

These two cars were built by the American Car and Foundry Company and embody that builder's standard construction, employing spot welding and riveting, as the basis for design. USS Cor-Ten steel is used extensively in the structural members and aluminum alloys for the interior finish and roof. The side sheets are Armco high-tensile steel. The principal weights and dimensions are shown in an accompanying table. The cars being designed especially for suburban service have wide center entrance doors and vestibules to facilitate speedy loading and unloading. The doors are of the sliding type, operated by air and controlled by the conductor. An innovation in arrangement appears in the ability to convert the unused operator's compartment at either end into a saloon when the cars are used for excursion trips. This is accomplished by means of an ingenious arrangement of door and window curtains.

Car Structure

The underframe is built up of rolled Z-section side sill members to which the transverse equipment supports and floor supports are welded. Rolled channel shaped center sills are welded in fore and aft of the bolster in order to carry the buffing loads back to the bolster and thence to the side girders. A combination of rolled Z shapes extending from side sill to side sill and isolated from the car floor are welded in to facilitate three-point suspension of the engine mounted beneath the floor.

The bolsters are the box section type of welded construction consisting of top and bottom cover plates and web plates. Flange stiffeners and gussets are welded in



The interior is in two sections, with equipment compartments and doors at the center

at the vulnerable points in order that the stresses will be smoothly transferred.

Light gauge steel false floor sheets are welded to the above-mentioned underframe members, thus forming a water tight and fireproof bottom covering for the floor.

The side frame is of girder type construction with rolled angles forming side sill or bottom chord and a light weight rolled Z-bar and rolled angles for side plate or top chord member. The posts are pressed flanged U-sections which when spot welded to the 14-gage side



The interior framing with the insulation in place

sheets form a stiff, light-weight box section. The belt rails and window headers consist of pressed Z-shaped members, and are arc welded to the side posts in such a manner that they function as continuous members.

These framing members are first assembled on jigs and then are arc welded, forming a skeleton to which the side sheets are spot welded.

The roof framing consists of light weight side plate angles to which are arc welded pressed Z-shaped carlines. Four Z-shaped purlines are welded to the carlines and run the entire length of the car and when riveted together with the carlines and the $\frac{1}{16}$-in. aluminum roof sheets form a stiff sub-assembly which is riveted to the side frames. Further rigidity is gained by the light trussed framing which is fastened beneath the carlines to support the headlining and the air-conditioning duct.

The end frame is built up of welded construction with substantial pressed end posts to meet A. A. R. requirements and extending from the center sills at the bottom to the anti-telescoping sheet at the top.

The ends accommodate five windows which give the operator excellent vision around the entire front of the car. Both ends of the car have been made the same, as the car operates in either direction.

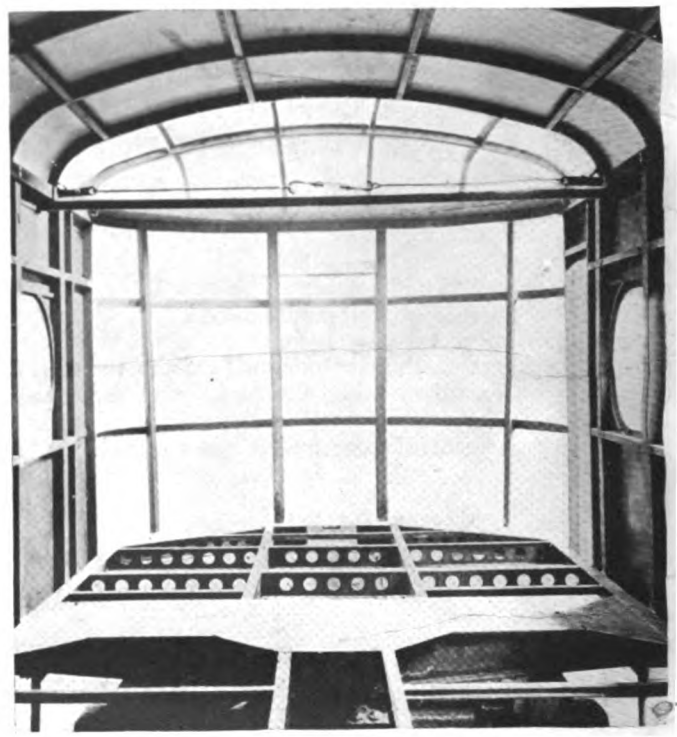
The Oil Engine

The power plant for these cars is an oil engine built by the Waukesha Motor Company, Waukesha, Wis., for the American Car and Foundry Company under license of the Hesselman Motor Company, Stockholm, Sweden.

While this engine is similar in many ways to the compression-ignition Diesel engine with its intake charge of air alone and its solid injection of the fuel oil, it differs from the conventional Diesel engine in employing a positively-timed electric ignition system supplied by high-tension magneto. The substitution of spark ignition for high-compression pressures and correspondingly high explosion pressures makes it possible to secure greater horsepower and greater flexibility from a given basic engine weight than is possible with conventional high-pressure Diesel engines.

The compression pressure at full throttle is approximately 135 lb. per sq. in. while the maximum explosion pressure at full throttle will hardly exceed 450-500 lb. per sq. in. This engine is a six-cylinder, horizontal, overhead valve unit with cylinders $6\frac{1}{4}$-in. bore by $6\frac{1}{2}$-in. stroke, and 1,197 cu. in. displacement. In the present form, employing a supercharger, the output of the engine is nearly 30 per cent greater than the conventional non-supercharged unit of the same size and is capable of propelling the car, fully loaded, at speeds up to 60 m. p. h. at 1,800 r. p. m. engine speed.

The upper side of the engine, beneath the floor, has the Bosch fuel injection pump and the Hesselman open-type nozzles which are easily accessible through trap

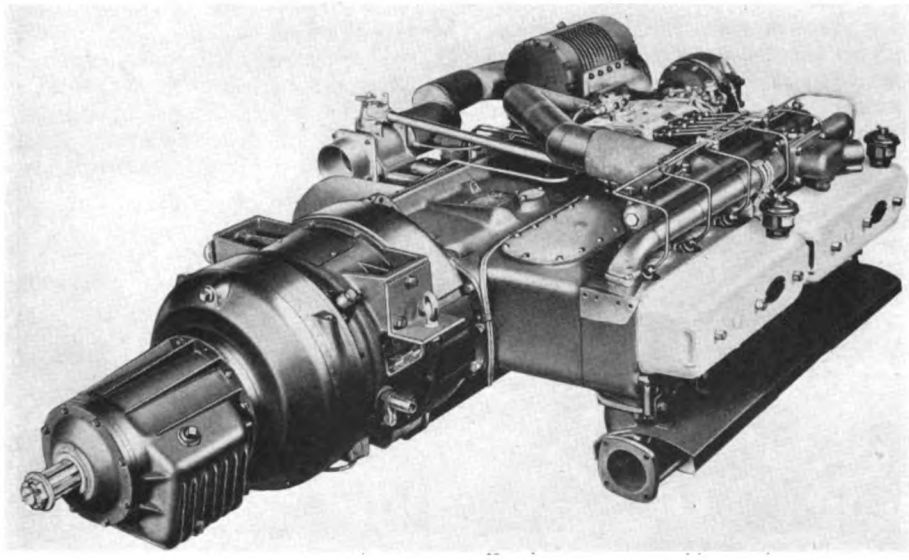


The framing between the bolster and the car end

doors from the interior of the car. On the same side is located the supercharging ducts and the throttle box controlled by a centrifugal governor built into the engine. The engine drives through a Twin Disc torque converter which carries the operation up to approximately 40 m. p. h. when the engineman's control is thrown into full running position and a direct drive clutch is engaged.

Overrunning clutches permit free coasting when the power is shut off. Including the super-charger, the 20-kw. generator for lighting, air conditioning and other auxiliaries, the parasite load on the engine is approximately 40-50 hp. at all times. The governor maintains the necessary speed and output to handle this automatically.

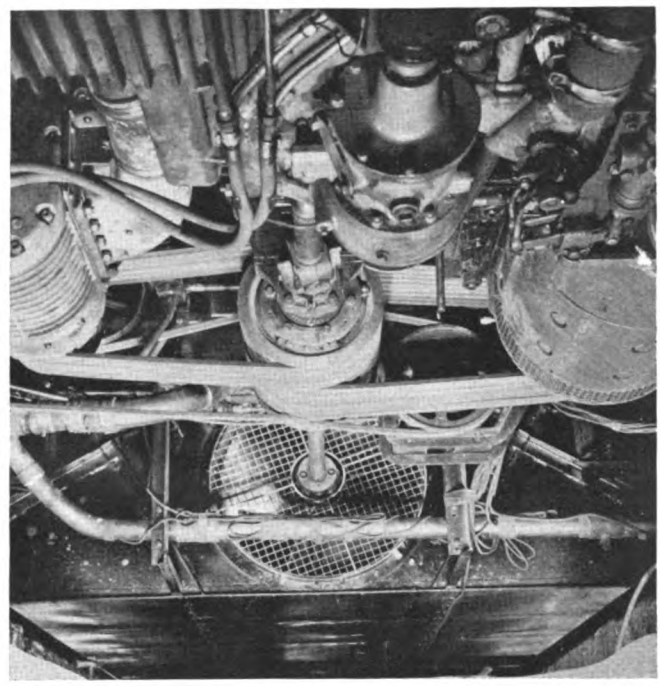
A separate head casting carries the intake and exhaust valves, the valve rocker arms and supports as well as the injection nozzle and spark plug. It is demountable for servicing and grinding of valves, and is



The Waukesha-Hesselman horizontal supercharged oil engine



The engine and transmission is installed entirely beneath the car floor and is accessible for adjustments



The principal auxiliaries, such as generators and air compressor are driven by V-belt from a main shaft sheave

arranged in two castings, each carrying the valve gear and mechanism for three cylinders.

The main crankcase consists of an alloy-iron outer case into which are inserted molybdenum-iron wet sleeve cylinders. At the valve end the sleeve is sealed against water leaks by the head and cylinder block gasket. At the opposite end, two composition rubber rings seal it against leaks into the crankcase. The crankshaft has seven 4 in. main bearings which ride in renewable steel-backed, babbitt-lined bushings. The connecting rods are equipped with similar precision bearings 3⅜ in. in diameter. Rifle drilling through the connecting rod brings oil under pressure to the piston pin which floats freely in a bronze bushed bearing at the small end of the rod and in broached holes directly in the aluminum bosses of the piston. A special hole drilled in the large end of the connecting rod provides an intermittent jet of oil which is thrown into the camshaft tunnel shown directly above it.

The oiling system is unusual in that the oil pump is built with two sections, one a scavenger section and the other a pressure section, and in addition to the main oil pump a second scavenger pump is located at the front end and driven directly by helical gears from the main crankshaft timing pinion. Throw-off from the crankshaft and other parts of the interior of the engine drains back into the outer sump which is separated from the main sump by a dam wall 12 in. to 14 in. high. The scavenger section of the main oil pump lifts the oil out of the scavenger sump and drops it into the main oil sump whence it is picked up by the pressure section of the pump and distributed through drilled passages in the case and suitable connections to all of the working parts of the engine.

An interesting feature of this engine is the fuel system. Unlike the high-pressure Diesel engine, the Hesselman engine controls both the fuel and the air employed so that a fuel-air ratio is maintained throughout

the entire speed and power range. Excessively lean mixtures at light load or excessively rich mixtures at heavy load are thus avoided and the smooth acceleration, absence of detonation and ignition delay due to variations in the fuel characteristics are avoided.

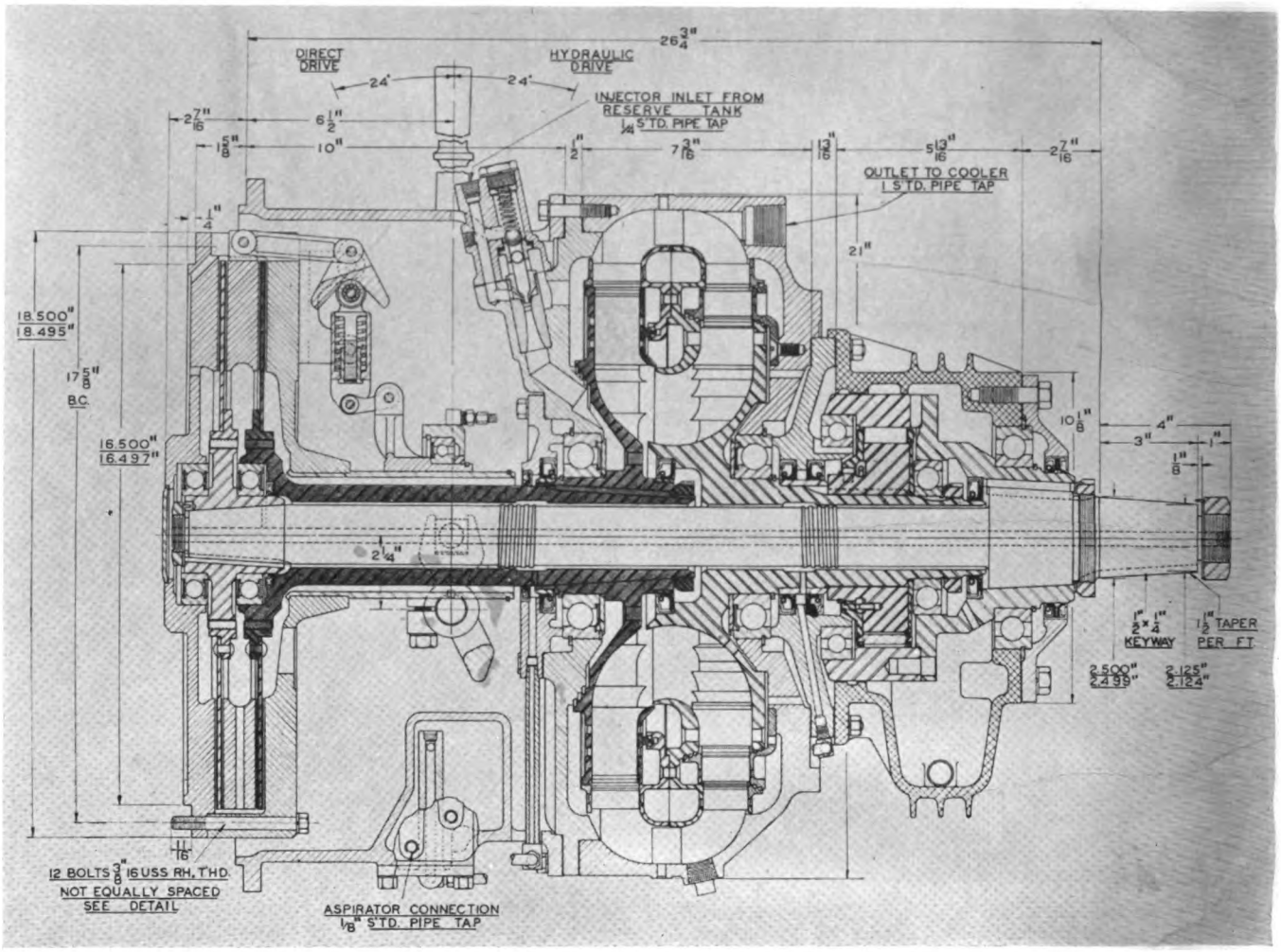
Speed control and the output of this engine is effected entirely by a simple butterfly valve in the air intake to the super-charger. As this throttle is closed, it creates a vacuum in the suction line of the supercharger which is communicated to a piston in a vacuum cylinder attached to the rear of the fuel pump. A vacuum, as it acts on this piston, moves the piston to the left and shuts off the fuel. When the butterfly is opened, the vacuum is reduced and the springs back of the piston move the fuel volume control to the right, feeding more fuel. A controlled and responsive adjustment results between the volume of air and the volume of fuel.

Hesselman nozzles employed with this Bosch injection system are of the open type with three simple ball check valves. There are no moving parts in the fire zone or the tip and only two orifices of relatively large diameter, .024 in. This construction with large passages and orifices reduces nozzle servicing problems and is possible because the low pressures employed in compression do not involve such high injection pressures.

The starting system is a standard 12-volt Delco starter, which is adequate for this engine, and is also made possible by the low engine pressures. Starting is effected by the injection of gasoline into the intake manifold for a short warm-up period followed by injection from the fuel oil system. The fuel useable in this supercharged engine is of the most economical type as it does not require a high cetane ignitibility rating. The maximum cetane recommended by the builders is 30 which permits the use of many low cost distillates and other fuels unsuited to compression ignition engines.

The Transmission

The transmission consists of a Twin Disc direct-drive converter containing a hydraulic torque converter, direct and free-wheeling feature; a drive shaft with midship bearing and universal joints to transmit the power to the drive axle on one axle of the truck. The mechanism on the drive axle is for forward and reverse operation and is made up of two floating spiral-bevel ring gears meshing with a common pinion. A jaw clutch sliding on splines on the axle shaft engages one ring gear or the other depending on which direction the car is to operate. The jaw-clutch-shifting mechanism is actuated by air cylinders controlled by an electric switch in the operator's cab.



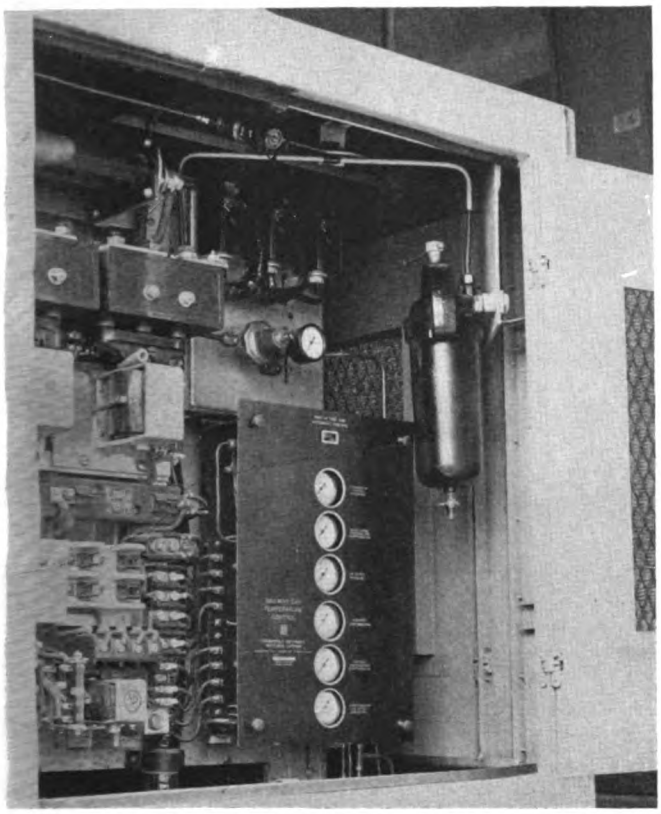
Sectional view of the Twin Clutch direct-drive converter with hydraulic torque converter

In the Twin Disc direct-drive converter the drive from the engine is taken through one or the other of two driving plates in a duplex clutch which has a spring-loaded over-center action. One of the clutch plates is mounted on a hollow shaft and is connected to the pump impeller of the hydraulic drive. The clutch plate nearest the engine engages the direct drive shaft passing through the hollow shaft and the center of the converter.

The shift from hydraulic into direct drive is made at

a speed of from 35 to 40 m. p. h., equivalent to an engine speed of about 1,200 r. p. m. Direct drive operation is from 1,200 to 1,800 r. p. m.

A freewheel is provided between the turbine and the output shaft in order to disconnect the turbine entirely when the unit is in direct drive. This disconnection eliminates losses due to the drag of the hydraulic parts.



Air conditioning control panel

The freewheel unit is the mechanical type consisting of rollers spaced by means of a cage between the inner cam and the outer race. When in hydraulic drive, the rollers are engaged and constitute the drive between the cam and the outer race mounted on the turbine hub and the output shaft, respectively. When in direct drive, the outer race overruns the cam, and the rollers are dropped back into the recesses in the cam. Lubrication is provided by constant circulation of oil through the unit. A separate oil-cooling unit is provided for the hydraulic unit.

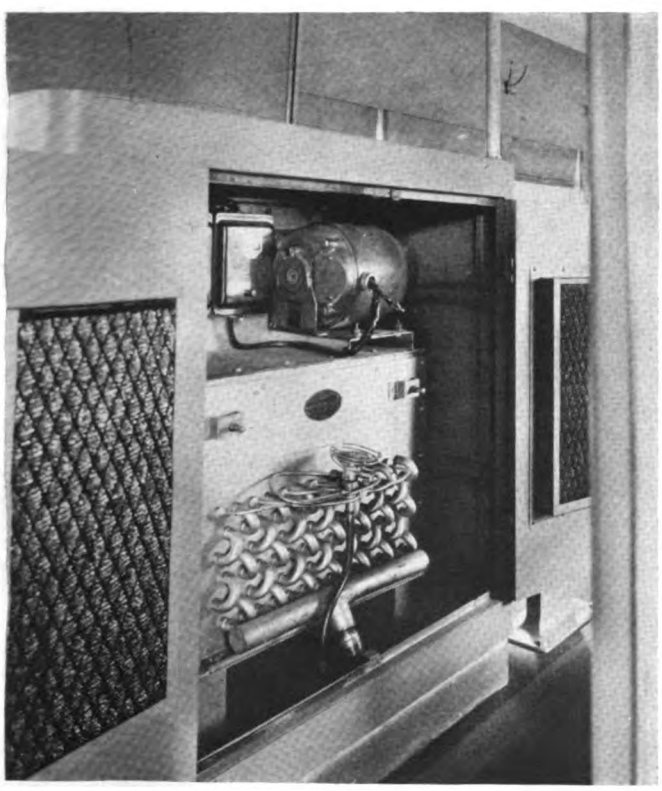
The clutch is actuated electro-pneumatically. An electrically controlled air cylinder shifts either clutch into engagement and provides a neutral position when both are disengaged. The clutch-operating cylinder is, in turn, controlled by electric switches in the operator's cab.

All accessories are driven by V belts from a main sheave which is in turn driven by a propeller shaft off the rear or timing gear end of the engine crankshaft. The accessories comprise the supercharger, 125-volt d. c. generator, 12-volt generator, engine cooling water pump and two Bendix-Westinghouse 12-c. f. m. air compressors.

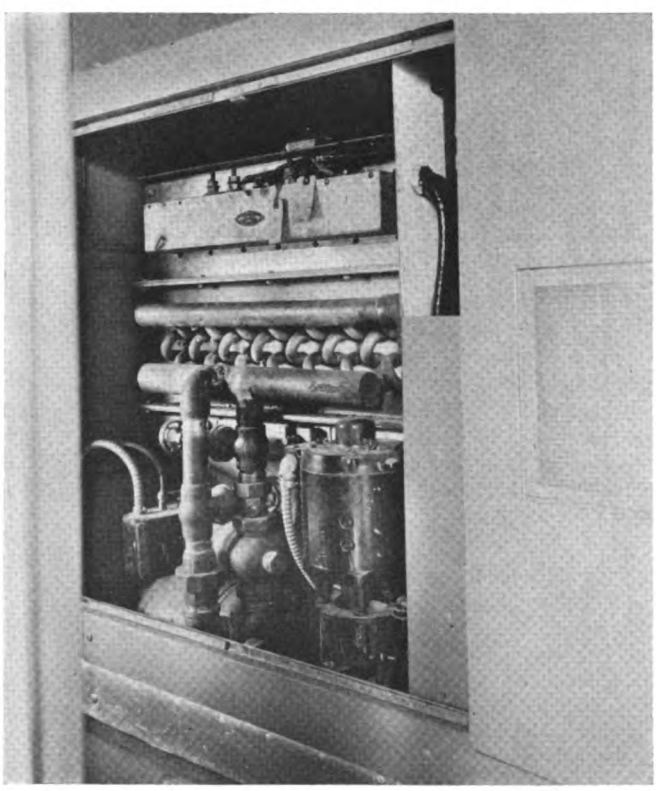
There are two sections of engine cooling water radiators arranged across the car immediately behind the accessories and their belt drives The radiator cores are of the fin and tube type. Engine water temperature is regulated by automatic thermostatically controlled radiator shutters. The radiators are cooled by two 27 in. dia. aluminum fans mounted on a common shaft. The fans are driven by a propeller shaft, having a flexible rubber joint at each end, one end of which is attached to the main belt sheave. The engine cooling water also cools the torque converter fluid by means of a heat exchanger.

Air Conditioning and Heating

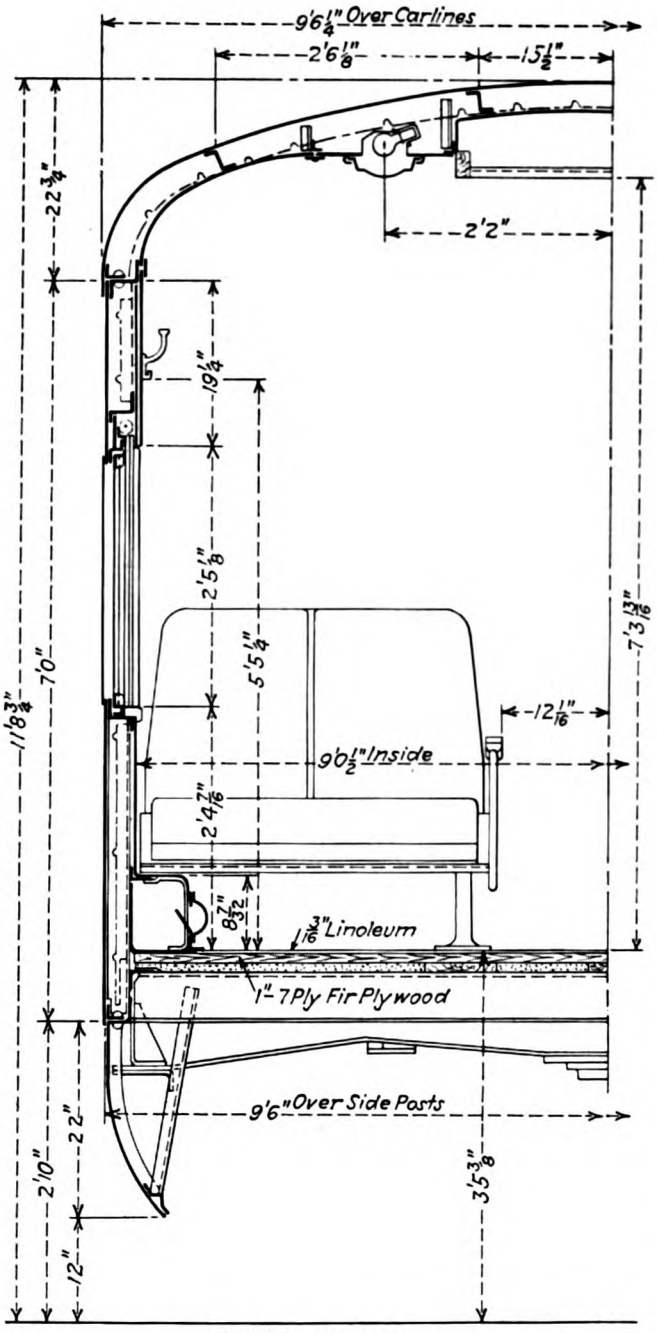
These cars are equipped with the American Car and



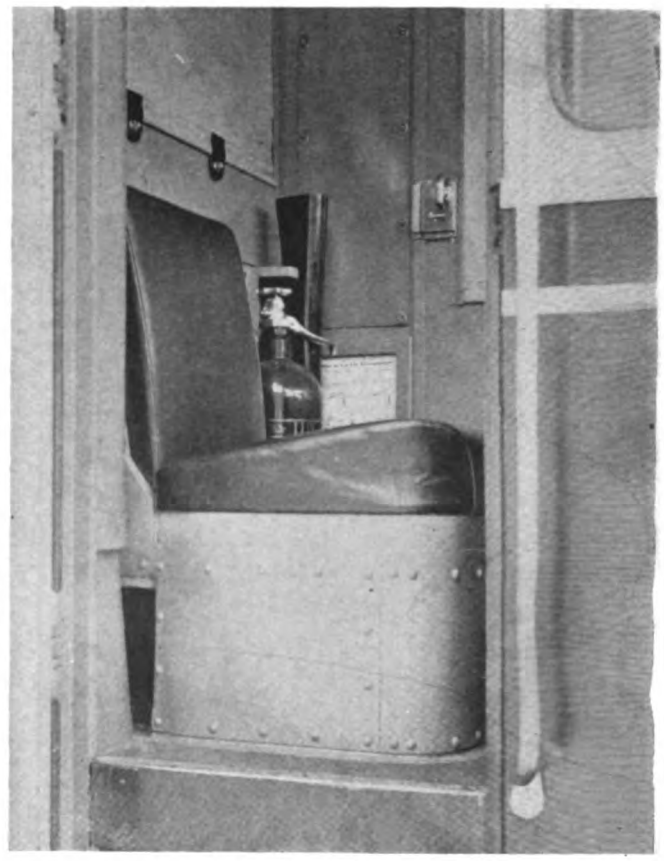
Evaporator and blower motor in aisle compartment



Water and electric heater in the opposite aisle compartment



Typical cross section



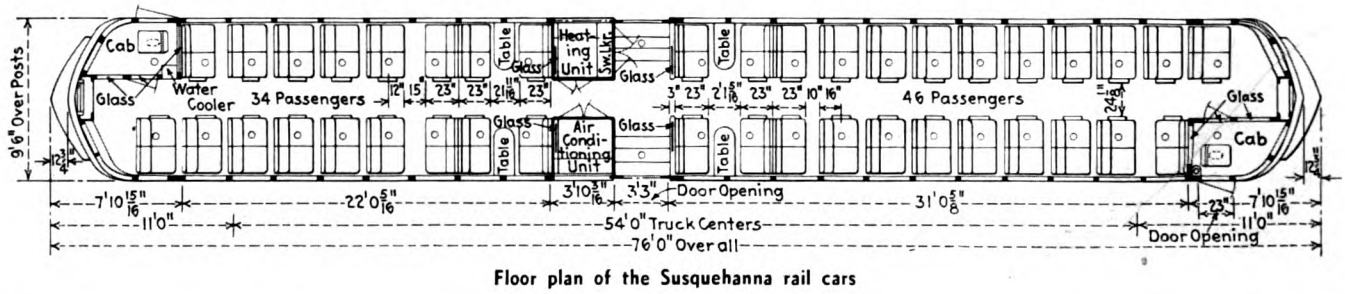
The operator's cab may be converted into a saloon

Principal Weights and Dimensions of the New York, Susquehanna & Western Lightweight Rail Cars

Light weight of body shell, lb.	19,550
Light weight of finished car body, lb.	54,120
Truck, drive, lb.	10,360
Truck, trailing, lb.	9,020
Total light weight on rails, lb.	73,500
Estimated water, fuel, oil, crew, etc., lb.	3,000
Total service weight on rails, lb.	76,500
Total load passengers and mail, lb.	12,200
Total loaded weight on rails, lb.	88,700
Length over pilots, ft.-in.	76-0
Width over side frames, ft.-in.	9-6
Height, rail to top of roof, ft.-in.	11-8¾
Height, rail to top of floor, ft.-in.	3-5⅜
Height, floor to ceiling air duct, ft.-in.	7-4
Seating capacity	80

Foundry Company's all-weather system. The air conditioning system of 6½ tons capacity is the electro-mechanical type using Freon. The motor-driven compressor and the condenser are beneath the car floor, accessible from the side, and the evaporator and fan equipment is located in one of two compartments at the center of the car adjacent to the doors. In the other compartment the heating equipment is installed. Fresh air is taken in through a duct below the compartment and the cold air passes out at the top into distribution ducts at the center of the car ceiling. The system is governed by automatic temperature and humidity control.

In the heating equipment compartment at the opposite side of the aisle there is a fin-type radiator through which the jacket water from the engine passes. A modulating valve in the hot water line to the heating coil proportions the volume of water to the heating de-



Floor plan of the Susquehanna rail cars

mand. The valve is actuated by a controller in the hot air discharge duct. The heated air is blown out into ducts near the floor at each side of the car. The heat derived from the above source is supplemented by a 12 kw. electrical heating unit in the same compartment. The heating system is under automatic control and compensates the temperature level as a function of the outside temperature and inside relative humidity.

Supplementing the air condition system, to be used in emergency, are two drop windows at each end of the car operating as air intakes. These windows are the crank down type. Single fixed sash are used for the remainder of the windows.

The cars are insulated throughout with Johns-Manville Stonefelt.

Electrical Equipment

The electrical equipment on these cars takes advantage of the dual voltage system using 12 and 125 volts. The 12-volt system is used for engine starting, engine safety devices, marker, classification and headlights. Each headlight is equipped with a 12-volt 30-ampere bulb, which has a pick-up distance considerably in excess of the conventional locomotive headlight. The 12-volt 25-plate battery is charged from 40 ampere generator belt driven from the engine.

The 125-volt system consists of a 20 kw. 125-volt, belt driven generator which is capable of delivery at rated capacity, while the power plant is operating over a speed range of nearly 4 to 1. Cool cleaned air for the generator is supplied through a louvred opening in the side of the car, which has a suitable dust connection to the generator. The generator supplies the necessary power for air conditioning, electric heat, lights, control and other electrical accessories, and at the same time charges a 56-cell KX-7-H Exide Ironclad battery.

The lighting is by means of Luminator fixtures at each seat location in the side ceiling. These fixtures are fitted with lenses which assure ample illumination at the reading plane.

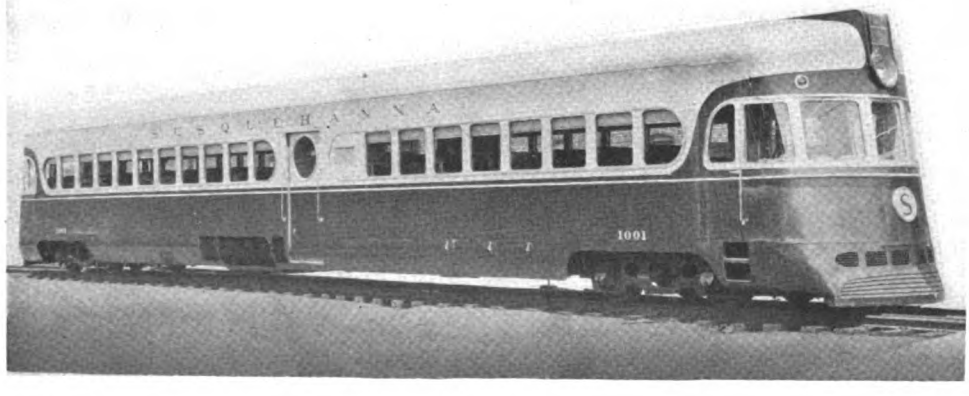
Trucks, Couplers and Brake Equipment

The cast-steel framed trucks are of four-wheel design. The truck bolsters are cast steel supported on transverse full elliptic springs. The axles are mounted in Timken roller bearings. The power application is through one axle of one truck. The brake cylinders are mounted on supports secured to truck frame cross members and are located just inside the wheels. Special attention has been given to sound deadening in the trucks. The cars are equipped with New York Air Brake Company's Schedule SME brake designed to stop from full speed in 24 sec. or 0.2 mile at a braking rate of 2.5 m. p. h. per second.

Coupler pockets are concealed under the sheathing at each end of the car; flush, removable covers are used in the sheathing.

Partial List of Material and Equipment on the New York, Susquehanna and Western Rail Cars

Aluminum	Aluminum Co. of America, Pittsburgh, Pa.
Steel	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Side sheets	American Rolling Mill Co., Middletown, O.
Step treads	Republic Steel Corp., Massillon, O.
Plywood	Harbor Plywood Corporation, Hoaqium, Wash.
Engine	Waukesha Motor Co., Waukesha, Wis.
Muffler	Burgess Battery Co., Madison, Wis.
Tachometer	Weston Electrical Instrument Corp., Newark, N. J.
Pulleys	Dayton Rubber Mfg. Co., Dayton, O.
Throttle control system	Bendix Products Div., Bendix Aviation Corp., South Bend, Ind.
Pulley and fan; voltage regulator; magnetic switch; starting motor	Delco-Remy Corp., Div. General Motors Corp., Anderson, Ind.
Propeller shaft bearing	SKF Industries, Philadelphia, Pa.
Propeller shaft and bearing	Spicer Mfg. Corp., Toledo, O.
Heat exchanger; radiators	Young Radiator Co., Racine, Wis.
Torque converter; sight level gasket	Twin Disc Clutch Co., Racine, Wis.
Rubber mounting torque converter stabilizers	U. S. Rubber Co., New York.
Pressure gage	Manning, Maxwell & Moore, Inc., Locomotive Equipment Div., Bridgeport, Conn.
Rubber hose, belts	Gates Rubber Co., Denver, Colo.
Water gage	Lunkenheimer Company, Cincinnati, O.
Copper tubing and fittings	Chase Brass & Copper Co., Inc., Waterbury, Conn.
Air filter	Air-Maze Corporation, Cleveland, O.
Roller bearings	Timken Roller Bearing Company, Canton, O.
Truck frames; bolsters	American Steel Castings Co., Newark, N. J.
Wheels; axles	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Springs	American Locomotive Co., Railway Steel Spring Div., New York.
Couplers	McConway & Torley Co., Pittsburgh, Pa.
Brake shoes	American Brake Shoe & Foundry Co., New York.
Air compressor	Bendix Westinghouse Automotive Air Brake Co., Pittsburgh, Pa.
Air brakes	New York Air Brake Co., New York.
Hand brake	National Brake Co., Buffalo, N. Y.
Glass	Pittsburgh Plate Glass Co., Pittsburgh, Pa.
Torque arm Neoprene pads; glazing cork strip	Armstrong Cork Co., Lancaster, Pa.
Insulation	Johns-Manville Sales Corp., New York.
Air conditioning	American Car and Foundry Co., New York.
Air conditioning controls	Minneapolis-Honeywell Regulator Co., Wabash, Ind.
Exhaust ventilating fans	Diehl Mfg. Co., Elizabethport, N. J.
Cooling fans	B. F. Sturtevant Co., Hyde Park, Boston, Mass.
Batteries	Electric Storage Battery Co., Philadelphia, Pa.
Generators	General Electric Company, Schenectady, N. Y.
Body lights	Luminator, Inc., Chicago.
Headlight reflectors; headlights	Electric Service Supplies Co., Metal Products Div., Philadelphia, Pa.
Bell operating valves	U. S. Metallic Packing Co., Philadelphia, Pa.
Fire extinguisher	Walter Kidde & Company, Inc., Bloomfield, N. J.
Air sander trap	Graham-White Sand Corp., Roanoke, Va.
Tyfon horn	Leslie Co., Lyndhurst, N. J.
Bell and ringer	American Locomotive Co., New York.
Door track valve	National Pneumatic Co., Rahway, N. J.
Linoleum	Armstrong Cork Co., Lancaster, Pa.
Body seats	Coach & Car Equipment Corp., Chicago.
Ajax cup dispenser	Logan Drinking Cup Div., U. S. Envelope Co., Worcester, Mass.



Combating

Locomotive Obsolescence*

By J. L. Ryan †

Improvements may be effected in capacity and economy by reproportioning locomotive parts subject to renewal—The author sets forth a number of specific suggestions

THE demand for faster service, longer runs and high mileage on the railroads has left almost all of them with many locomotives which are not adapted to meet such requirements. In other words, the horsepower demand cannot be met. Many of these locomotives may be improved for faster and more sustained service by making changes which will not incur a great deal of expense.

Degree of Obsolescence of Nation's Motive Power

In attempting to approximate the extent to which our road-service steam motive power may be considered modern, the author uses as an example the locomotives of the St. L.-S. F., which is considered an average-size railroad. Out of an ownership of 610 locomotives, 425 or 70 per cent are assigned to road service. In view of the speeding up of freight and passenger schedules, the horsepower rating of locomotives is a better yardstick to apply than the rated tractive force which is so frequently used. Thus, using Cole's values for cylinder-horsepower rating for locomotives built prior to 1920 and the railway company's test results for those built in 1920 and later, the 425 locomotives having road assignment have a rating of 1,096,100 hp., an average of 2,579 hp. each. Table I indicates the periods in which certain of these locomotives have been built.

Table I—Period of Building Locomotives of the St. Louis-San Francisco Railway

	Horsepower rating	Percentage of total
1935 and later	132700	12.0
1930 and later	220700	20.0
1923 and later	543200	49.5
1919 (U. S. R. A.) and later	623500	56.7

Of the locomotives producing 220,700 hp. built or rebuilt in 1930 and later, only 132,700 hp., or 12 per cent of the total considered, fully meet the transportation department's operating requirements and have the desired proportions for economy of operation and maintenance. There are 31 locomotives included in this 12 per cent, having an average rating of 4,300 hp. Numerically, these locomotives are 7.3 per cent of the total having road-service assignment.

Now considering the railroads as a whole, we find that in 1939 reports were filed for 45,965 steam locomotives. Should the road-service ratio of 70 per cent be applied to the 45,965 steam locomotives reported in order to arrive at the approximate number having road assignment, we would have a total of 32,175.

The record of purchases of steam locomotives for service in the United States 1934 to 1939, inclusive, is given in Table II. Numerically, the 699 steam locomotives listed in Table II, purchased for road service, constitute only 2.2 per cent of the 32,175 steam locomotives considered as having assignment to this service. These new locomotives have approximately double the rated horsepower capacity of the average of the total and accumulate mileage at rates two to three times that of the average. On this basis, they should account for 10 to 15 per cent of the transportation movement. This leaves 85 to 90 per cent of the movement being handled by locomotives built prior to 1934. A number of the freight locomotives, built in the period 1928 to 1931, were proportioned to meet present operating requirements; the majority, however, while having good boiler proportions and good steam distribution, continued with wheel diameters which are a handicap today.

Returning to the figures on the locomotive ownership of the St. L.-S. F., it will be observed that, of the 1,096,100 rated horsepower, representing the total capacity of the 425 locomotives assigned to road service, locomotives having 12 per cent of the rated total are considered modern, while locomotives accounting for 44.7 per cent of the rated total were built commencing with the U. S. R. A. period and from then on to the time when those having modern operating proportions were constructed.

With the groups of locomotives in mind which will fall within the period of construction of the 44.7 per cent mentioned, it is suggested that studies similar to the following be undertaken with the object of making maintenance replacements as nearly according to modern proportions as possible in preference to the "as-built" proportions. Regardless of our opinions with respect to the economical retirement age of equipment, these locomotives will, in all probability, be continued in service for many years.

Table II—Steam Locomotive Purchases: 1934-1939

Construction orders placed	Service	
	Road	Yard
1934	63	9
1935	17	11
1936	349	84
1937	149	27
1938	33	2
1939	88	2
Total	699	135

In some instances at no additional cost, and in many instances at a nominal additional cost, distinct improvements may be effected in the capacity and economy of locomotives by the reproportioning of parts which are subject to renewal from time to time through the routine of maintenance.

Boiler Proportions Which Should Be Examined

The boiler is an excellent starting point when reviewing the design and proportions of a locomotive for possible improvement.

Many of the boilers designed in the days of drag

* Abstract of a paper presented at a session of the Railroad Division at the semi-annual meeting of the American Society of Mechanical Engineers at Milwaukee, Wis., June 17-20, 1940.

† Mechanical engineer, St. Louis-San Francisco.

service have inadequate steam space for the high steam-release rate obtained under present operating conditions. When a new firebox is applied, this condition can be readily corrected. The lowering of the crown sheet 3 in. will increase the volume of the steam space 20 to 25 per cent. This is frequently sufficient to transform a poor water-carrying boiler into a good performer. When this is effected, the results are: (a) better performance on line of road; (b) higher superheat temperature; (c) reduction in maintenance of valves, pistons and superheater units.

Locomotives designed for operation on heavy-grade lines and having permanent reassignment where only light-grade lines are encountered, should be checked for the lowest reading of the water glass relative to the highest point of the crown sheet and for the visible length of the water glass used. A gain of 15 to 20 per cent in steam space is at times possible by a slight lowering of the water glass and reduction in its visible length, maintaining the same degree of safety in operation on the light-grade line as prevailed on the heavy-grade line for which the locomotives were built.

The gas area through the barrel of the boiler is one of the all-important details which should be checked in order to provide the maximum attainable. In the design of locomotives constructed in the period 1919 to 1930, temperatures of 700 to 750 deg. F. when we apply new tube sheets in the course of maintenance, the reproportioning of the tube layout to provide high steam-chest temperatures offers an excellent opportunity for increased capacity and economy.

The tube-sheet layout of the U. S. R. A. locomotives is proportioned so that the 5½-in. flues will have a gas area of 45 to 46 per cent of the total gas area through the boiler. Such a proportion with the Type A superheater gives a steam temperature approximately 100 deg. F. below that desired in today's operation.

Table III shows the tube-and-flue application with resulting proportions for the U. S. R. A. 2-8-2 B type locomotive as built, as well as a number of possible applications without requiring any change in the crown height or water space around the combustion chamber. The order of application to attain increased capacity, as well as for fuel economy, would be as follows: (1) Type E superheater; (2) a 6-in. by 9-in. layout of 5½-in. flues with the application of Type HA superheater units or their equipment; (3) a 6-in. by 10-in. layout of 5½-in. flues with the top corner flues omitted; application of 58 Type A superheater units.

Increasing the capacity of the superheater effects a material gain in addition to that of reducing the steam rate per unit of work, since the increased number of

Table III—Possible Tube and Flue Applications on U. S. R. A. 2-8-2 B Type Locomotive Without Change in Dimensions of Back Tube Sheet

Superheater type	A	HA or equivalent	A	E
Superheater flue layout	5 × 9 (as built)	6 × 9	6 × 10	.....
Distance over tube sheets, ft.	19	19	19	18
Number of 5½-in. flues	45	54	58	201-3½
Number of 2¼-in. tubes	247	217	196	62-2¼
Vertical pitch of 5½-in. flues, in.	6½	6½	6½	4.22 (mean pitch)
Pitch of 2¼-in. tubes, in.	3	2⅝	2⅝	3
Heating surface of flues, sq. ft.	1226	1471	1580	3298
Heating surface of tubes, sq. ft.	2752	2418	2184	697
Total heating surface, tubes and flues, sq. ft.	3978	3889	3764	3995
Superheater heating surface, sq. ft.	993	1742	1280	1920
Steam area through superheater, sq. in.	51.3	61.6	66.1	71.92
Net gas area through boiler, sq. in.	1414	1447	1438	1427
Net gas area through 5½-in. flues, per cent	45.1	52.9	57.2	.....
Approximate temperature range of steam in branch pipe, deg. F. at high work rate	630-640	HA 710-730	700-720	710-730
Maximum evaporation, tubes and flues (Cole's values)	37984	37125	36175	39320
Maximum evaporation, including firebox heating surface (Cole's values)	54809	54010	53060	56205

some railroads incorporated practices in the spacing of tubes which, today, are recognized as not being consistent with spacing that may be followed with good results, water treatment and welded flues effecting this permissible change.

A case in point was the building some years ago of 50 2-8-2 locomotives by a certain railroad, following in detail the boiler dimensions of the U. S. R. A. 2-8-2 B type, except for the layout of the tube sheets. The latter type had 45 flues 5½ in. in diameter and 247 tubes 2¼ in. in diameter. The 50 locomotives of the 2-8-2 type mentioned have 45 flues 5½ in. in diameter and 219 tubes 2¼ in. in diameter.

A kindred condition can also be found in the proportioning of some boilers having combustion chambers with the water space around the chambers greater than is now required for good practice. The area of the back tube sheet is generally the limiting factor in the tube application to these locomotives. A reduction of the water space around the combustion chamber when applying a new firebox could be capitalized upon through the application of additional boiler tubes.

Boiler-Tube-Sheet Layout and Superheat

With the results at hand on the improved cylinder performance of modern and semi-modern locomotives, a high percentage of which is attributable to steam-chest units reduces the pressure drop, which at a high work rate is equivalent to a substantial increase in the boiler pressure.

Table IV contains examples of reproportioning the superheater application on two classes of locomotives by the St. L.-S. F.

Effect of Valve Events on Locomotive Operation

As important as the proportioning of the boiler and the superheater are the valve events upon the operation of a locomotive. Classes should be checked having in mind today's assignment. A 4-6-2 type built to handle the heavy trains of another period with valves having 1 to 1⅛-in. steam lap, should not be assigned to light, high-speed trains without altering the valves and valve gear to provide events to suit. Locomotives of the 2-8-2 type designed in the days of drag service may be found operating on near passenger schedules and with practically the original restricted steam ports and valve events. This necessarily results in loss of power and fuel.

Classes which are receiving the application of new cylinders should have the diameter of the valve, area of the exhaust channels, and the steam ports carefully examined. They should be proportioned to meet today's requirements. Only a few locomotives need be involved to justify the cost of a new cylinder pattern, should it be required, in order to obtain the desired proportions.

Table IV—Examples of Reproportioned Tube-Sheet Layout by St. Louis-San Francisco Railway

	Example No. 1			Example No. 2	
	As built	Reproportioned	Reproportioned	As built	Reproportioned
Superheater type	A	A	HA	A	A
Superheater flue layout	5 × 9	7 × 9	6 × 9	5 × 8	6 × 8
Combustion chamber—with or none	With	With	With	None	None
Back tube sheet altered	..	No	No	..	Crown sheet lowered 3 in.
Distance over tube sheets, ft.-in.	22-0	22-0	20-0	21-0	20-11
Number of 5½-in. flues	45	63	54	38	48
Number of 2¼-in. tubes	251	211	242	225	176
Vertical pitch of 5½-in. flues, in.	6¾	6½	6½	6½	6½
Pitch of 2¼-in. tubes, in.	3⅛	3⅛	3⅛	3⅛	3⅛
Heating surface of flues, sq. ft.	1420	1988	1548	1144	1440
Heating surface of tubes, sq. ft.	3240	2724	2839	2772	2160
Total heating surface, tubes and flues, sq. ft.	4660	4712	4387	3916	3600
Superheater heating surface, sq. ft.	1233	1726	1834	978	1235
Steam area through superheater, sq. in.	51.3	71.8	61.6	43.3	54.7
Net gas area through boiler, sq. in.	1426	1556	1500	1245	1233
Net gas area through 5½-in. flues, per cent	44.7	57.4	49.3	43.3	55.2
Temperature range of steam in branch pipe, deg. F., at high work rate	590-620	690-710	†690-720	....	680-700
Maximum evaporation, tubes and flues (Cole's values)	41,610	42,220	41,370	36,010	33,170

†Combustion chamber lengthened and syphon applied. Firebox heating surface increased 18.3 per cent.

Considering the fact that locomotives in freight service are rated today on their power output at piston speeds of 1,200 to 1,400 ft. per min., instead of on their initial tractive force, the responsibility devolves upon the mechanical engineers at least to point out the potential power increases which may be effected through moderate changes. At the time of heavy shopping, a valve gear, providing drag-service events, can be replaced with a gear providing modern events, often at slight cost over that which would be involved in maintaining the original in kind.

Table V, examples Nos. 1 and 2, are instances of altering the valve gears to meet changed assignments and operating conditions. In both cases the originals were for passenger service with running speeds of 55 to 60 m. p. h. The alterations were made to provide valve events to accommodate an economical cruising speed of 70 to 75 m. p. h., with occasional top speeds of 80 to 85 m. p. h.

What proportions and valve events should be provided to meet today's operating requirements most satisfactorily? The locomotives which we are considering are those built from 1919 to 1930, the majority having working pressures within the range of 200 to 250 lb. per sq. in.

The problem is to provide the highest possible mean effective pressure at piston speeds of 1,200 ft. per min. and higher. L. H. Fry's recent review* of the reproportion of locomotives by the Paris-Orleans Railway may be read to advantage by those having to do with steam-locomotive proportions; also by those having to do with maintenance. In the latter case, the review should be studied in order that a better understanding will exist when a slight increase in maintenance is assumed in order to effect a substantial increase in the work-rate capacity.

Indicator cards, Figs. 1 to 4, inclusive, are shown as an example of the increase in mean effective pressure which may be effected through the adoption of a long steam lap. They were taken from a 2-8-2 type locomotive having 45 Type A superheater units, 27-in. by 32-in. cylinder, 14-in.-diameter valves, 8¾ in. maximum travel. The valve setting for cards, Figs. 1 and 3, was as follows: 1¼ in. steam lap, 3/16 in. lead, 0 in. exhaust clearance, 1⅝ in. width steam port. The valve setting for cards Figs. 2 and 4 was as follows: 2½ in. steam lap, 3/16 in. lead, 1/16 in. exhaust lap, 2 3/16 in. width steam ports.

Example No. 3, Table V, shows the steam lap, lead, exhaust clearance, valve diameter, maximum cut-off, etc., which the St. L.-S. F. uses as the most practical for fast heavy freight service. With a 1 15/16 in. steam lap and valve travel to provide 75 to 77 per cent maximum cut-off, auxiliary starting ports are not required. Cards shown in Figs. 5 and 6 were taken from the 2-8-2 type locomotives listed in Table V having 14 in. diameter valves with 1 15/16 in. steam lap. These cards were taken when the locomotive was operating with a piston speed of approximately 1,000 ft. per min.

It is not difficult to visualize the shrinkage in the mean effective pressure which would result from either a reduction in the diameter of the valve or in the steam lap.

With today's piston speeds of 1,200 to 1,600 ft. per min., it is doubly important that the inflow and outflow of steam be as unrestricted as is practicable. The use of valves of a diameter which may be considered large need not incur excessive weight. Lightweight built-up valves using gas pipe with a wall thickness of 3/16 in. and steel castings having ¼-in. section have been standard practice with the St. L.-S. F. for seven years.

Boiler Pressure

In the light of the excellent on-line-of-road operation which has been obtained from locomotives of recent

* "The Locomotive in France," by L. H. Fry, *Railway Mechanical Engineer*, December, 1938, page 473; January, 1939, page 1, and September, 1939, page 345.

Table V—Comparison of Change in Valve Events Made by the St. Louis-San Francisco to Meet Altered Operating Requirements With Examples of Recent Construction

	Example No. 1		Example No. 2		Example No. 3 Recent construction		
	Original	As altered	Original	As altered			
Locomotive type	4-6-2	4-6-2	4-6-2	4-6-4	2-8-2	4-8-2	4-8-2
Class of service	Passenger	Light fast passenger	Heavy passenger	Conversion, heavy fast passenger	Freight	Freight	Freight
Boiler pressure lb. per sq. in.	200	200	210	225	235	250	210
Cylinders, diameter and stroke, in.	24 × 28	24 × 28	26 × 28	26 × 28	27 × 32	27 × 30	29 × 32
Drivers, diameter, in.	69	73	74	74	64	70	70
Valves, diameter, in.	13	13	13	13	14	14	15
Maximum travel, in.	7½	7½	6½	7½	8½	7¾	8¼
Steam lap, in.	1¼	1½	1	1⅝	1⅝	1¾	1⅝
Lead, in.	¼	3/16	¼	3/16	3/16	3/16	3/16
Exhaust clearance, in.	¼	3/16	¼	3/16	0	0	0
Maximum cutoff, per cent	...	82	...	79	77	77	76

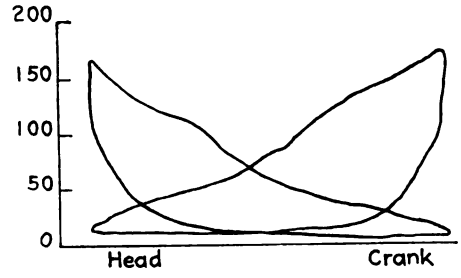


Fig. 1

Piston speed, ft. per min.	953
Cut-off, per cent	36.5
Boiler pressure, lb. per sq. in.	199
Mean effective pressure, head end, lb. per sq. in.	53.8
Mean effective pressure, crank end, lb. per sq. in.	66.7
Horsepower, right side	1,004
Total engine horsepower	2,008

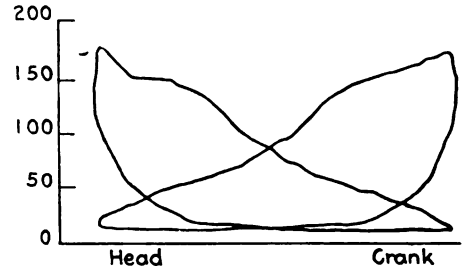


Fig. 2

Piston speed, ft. per min.	1,041
Cut-off, per cent	35.8
Boiler pressure, lb. per sq. in.	195
Mean effective pressure, head end, lb. per sq. in.	60.2
Mean effective pressure, crank end, lb. per sq. in.	76.1
Horsepower, right side	1,330
Total engine horsepower	2,660

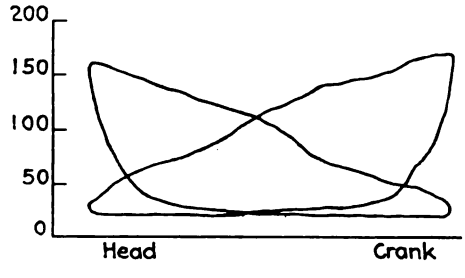


Fig. 3

Piston speed, ft. per min.	991
Cut-off, per cent	53
Boiler pressure, lb. per sq. in.	198
Mean effective pressure, head end, lb. per sq. in.	67.7
Mean effective pressure, crank end, lb. per sq. in.	76.8
Horsepower, right side	1,257
Total engine horsepower	2,514

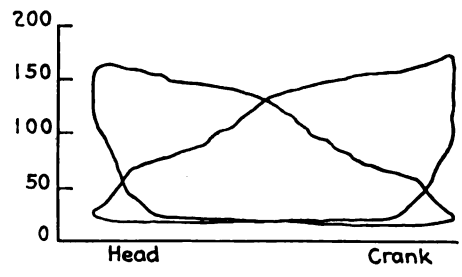


Fig. 4

Piston speed, ft. per min.	964
Cut-off, per cent	51
Boiler pressure, lb. per sq. in.	193
Mean effective pressure, head end, lb. per sq. in.	86.6
Mean effective pressure, crank end, lb. per sq. in.	93.8
Horsepower, right side	1,531
Total engine horsepower	3,062

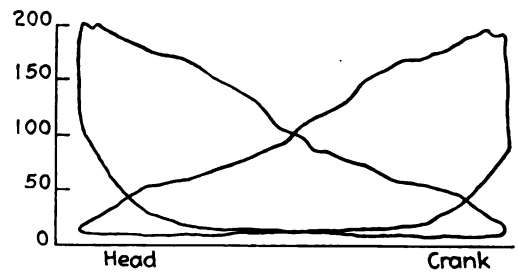


Fig. 5

Piston speed, ft. per min.	1,041
Cut-off, per cent	38
Boiler pressure, lb. per sq. in.	237
Mean effective pressure, head end, lb. per sq. in.	91.3
Mean effective pressure, crank end, lb. per sq. in.	92.3
Horsepower, right side	1,629
Total engine horsepower	3,258

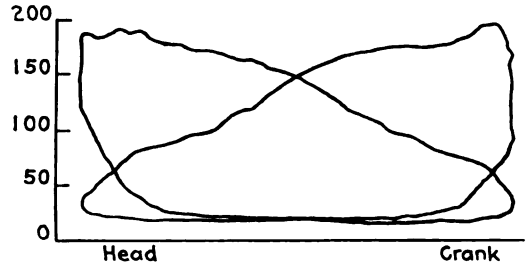


Fig. 6

Piston speed, ft. per min.	1,016
Cut-off, per cent	52
Boiler pressure, lb. per sq. in.	237
Mean effective pressure, head end, lb. per sq. in.	111.5
Mean effective pressure, crank end, lb. per sq. in.	115.0
Horsepower, right side	1,960
Total engine horsepower	3,920

construction with working pressures within the higher pressure range, one might be inclined to the thought that the 200 to 225 lb. per sq. in. working pressure to which many of the locomotives built in the 1919 to 1929 period are limited, presents an extreme handicap to one attempting to provide increased economy and power with which to meet today's operating requirements.

From the economy viewpoint, some encouragement may be obtained from a review of the design of the recently built high-pressure locomotives. The adoption of the higher working pressures without modification of design to provide for increased ratio of expansion does not admit of the increase in thermal efficiency of the engine which is ordinarily considered a result of the use of the higher pressure. The decrease in the differential between the two is particularly true where a heavy work

rate with reduced ratio of expansion is involved, the locomotives in both pressure ranges working at approximately the same cut-off or with the same ratio of expansion.

High pressure is forced at times where high piston thrust is required, and the cylinder diameter must be limited to keep within clearance limits. There is no denying that high pressure gives an engine a "smartness" of response; however, from the standpoint of capacity and for operation within the present operating requirements of high-speed freight service, much may be accomplished with working pressures of 200 to 225 lb. per sq. in. An example of this is where the two groups of 4-8-2 type locomotives listed in example No. 3 of Table V are in a pool. The steaming capacity of the locomotives in the two groups is approximately the same. The 250-lb. locomotives have 54 Type HA superheater units with 61.6 sq. in. of steam area through them. The size of the valves, events, etc., are given in Table V.

When it was decided to condition the group of locomotives having 210 lb. per sq. in. to work in a pool with the 250-lb. locomotives, the 5½-in. flues were increased from 45 to 53, with a resulting increase in steam area through the superheater units from 51.3 to 71.8 sq. in.; the dry pipe and branch pipes were increased to suit; 29-in. cylinders having 13-in. valves were replaced with 29-in. cylinders having 15-in. valves; valve gears providing 6½-in. maximum travel were replaced with gears providing 8½-in. maximum travel; valves having 1-in. steam lap were replaced with valves having $1\frac{5}{16}$-in. steam lap. There is some difference in the response of the two groups, so far as the enginemen are concerned, but none, so far as the dispatchers are concerned, both handling the same tonnage on the same schedules.

Steaming Capacity-Value of Feedwater Heating

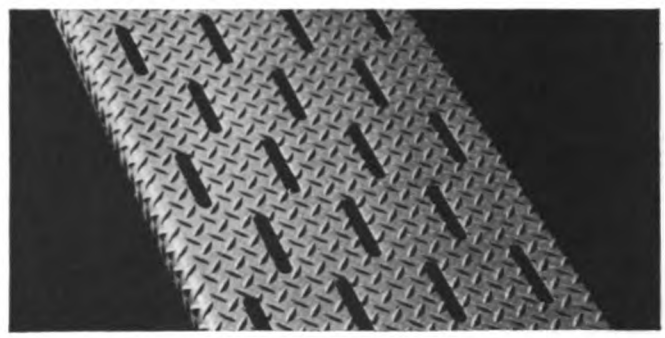
When treating the subject of providing the maximum possible capacity in existing steam locomotives, the steaming capacity which may be added to the boiler at high work rates by the application of feedwater-heating equipment, utilizing exhaust steam, should be analyzed and a distinction made between the percentage of return on the investment and the percentage increase in power; also that a net 10 per cent increase in boiler capacity is 12 to 13 per cent at the drawbar.

Conclusion

The groups of locomotives that were built in the years 1919 to 1930 offer in general, a fertile field for a substantial addition to the work-rate capacity of our locomotives through the adoption of a policy of providing proportions to give a high degree of superheat, low pressure drop from boiler to steam chest, and valve events to conform with present-day operating requirements, these changes building up the mean effective pressure at the higher work rates without increasing the maximum stress in frames, driving axles, crankpins, rods, etc.

Slotted-Type Steel Running Boards

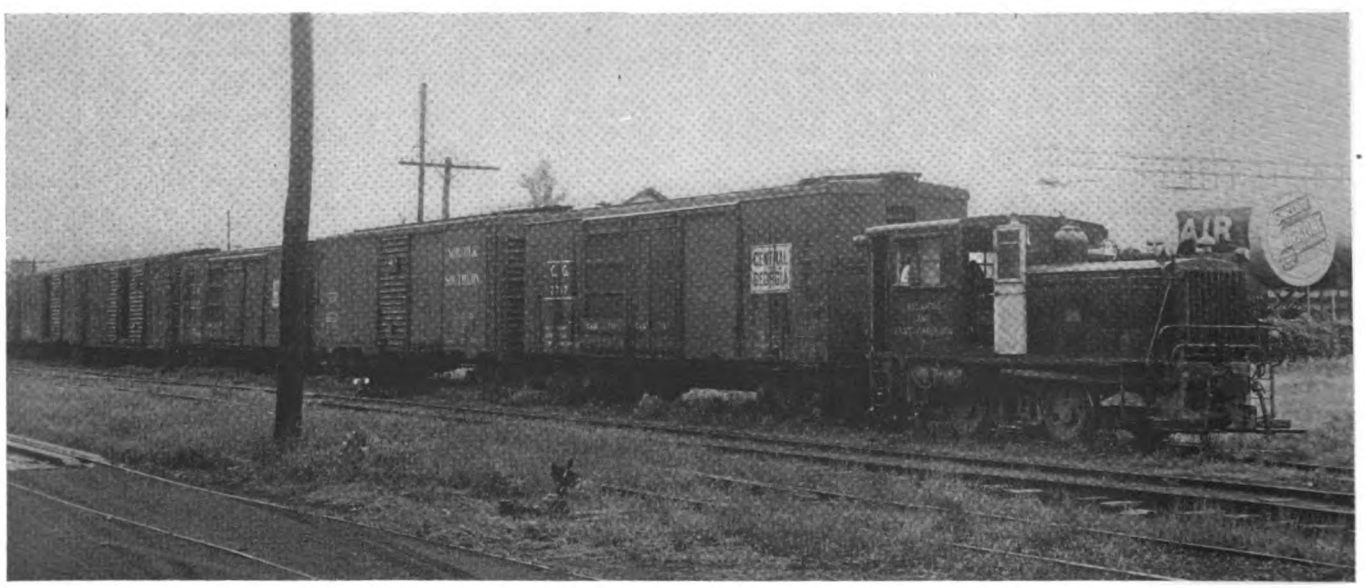
A section of the patented A. W. slotted-type steel running boards, developed by the Alan Wood Steel Company, Conshohocken, Pa., for railroad use, is shown in the illustration. These running boards are made from



The Alan Wood super-diamond steel running boards of hand-hold size are slotted for extra security

solid-steel plate to minimize the possibilities of corrosion and to give maximum service during the life of the car. The slots are of hand-hold size for extra security and the arrangement of these slots is designed to insure additional protection against dangerous falling accidents.

* * *



Plymouth 30-ton Diesel locomotive with Caterpillar engine at work on the Atlantic & Eastern Carolina

EDITORIALS

Air Conditioning—Asset or Liability?

A number of passengers on a well-known long-distance train of modern equipment were subjected to serious discomfort and possibly had their health placed in some jeopardy by failure of the air-conditioning controls in the car which they occupied, resulting in a temperature of 55 deg. F. throughout most of the trip. In spite of repeated efforts of the train crew to remedy the difficulty, the condition was not corrected and one of the passengers was heard to remark that he would not ride that train again even if he had no fare to pay. On another recent occasion, a passenger complained of drafts in the car in which he was riding to which the porter mumbled some half-audible explanation. On repetition of the complaint a short time later, the porter said "Yo is just unfortunate, suh, in having a seat under that outlet!" In still a third case, a passenger entered an air-conditioned coach of somewhat ancient vintage in a local train and noticed a very definite and objectionable smell of tobacco smoke, body odors and stale air. His unfavorable reaction was in no way diminished by the fact that, after being in the car for half an hour or so, he became accustomed to this condition and his sense of smell no longer rebelled.

Without in any way minimizing the tremendous achievement of the railroads in applying modern air-conditioning equipment to such a large proportion of their principal passenger trains, it seems apparent that further efforts must be made: (1) to install equipment which will produce desired results and be positively trouble free insofar as practicable; (2) to develop a maintenance force and methods of inspection and maintenance designed to assure maximum reliability of operation; and (3) to instruct train crews in the proper handling of the air-conditioning controls and, possibly of equal importance, teach them how to treat passengers and what to do for them in any of the various contingencies which may arise.

Unquestionably, the great majority of air-conditioning equipment now in service in railway passenger cars functions with general satisfaction. It makes riding under severe temperature conditions, whether of heat or cold, much more tolerable than ever before and gives passengers a service under these conditions which can usually be secured in no other transportation vehicle. While no figures appear to be immediately available regarding failures of air-conditioning equipment, expressed as inoperative air-conditioning car-miles divided by total air-conditioned car-miles, the indications are that this is a pretty sizable percentage. Unless railroads, therefore, are on the alert to detect quickly and correct all conditions which tend to prevent air-conditioning apparatus from functioning as intended, there is danger that this modern appliance, designed to attract passenger traffic to the rails, may become to an increasing extent less of an asset and more of an actual liability.

Proper Car Inspection To Reduce Train Delays

In discussing the relation of car inspection to train delays at the last annual meeting of the American Association of Railroad Superintendents in Chicago, the differences between Class A and Class B inspection were explained, the Class A consisting of a thorough inspection of all parts of cars before loading to make sure that the cars will carry their loads to destination without loss, damage or delay due to failure of any part as the result of existing defective parts.

Class A inspection requires careful examination of wheels, truck sides, bolsters, truck and body center plates, side-bearing clearances, sills and underframe. Couplers, knuckles, knuckle locks, lock set and anti-creep must be working properly and within specified limits of wear and contour, and couplers must be adjusted to the proper heights. Draft gears must be examined for slack, and stops, yokes, draft keys inspected, as well as all safety appliances. On box-type cars, the condition of floors, sides, ends, roofs and doors must be ascertained. Running boards and roof handholds must be in first class condition. On open-top cars, the condition of floors, sides, ends, doors and door locking mechanism must be ascertained.

Class B inspection, on the other hand, is a general and careful observation of cars to detect defects that might have developed after receiving the last inspection, special attention being given to trucks and safety appliances. While car inspection methods deviate in some details on various railroads, it is obvious that general inspection standards should be maintained as uniform as possible, with more attention paid to inspection for commodity classification. Any care exercised to assure the mechanical fitness of cars to meet the requirements of general service, as well as particular loads, is bound to show large returns in reduced train delays and attendant operating expense.

For example, some roads make a Class A, or 100 per cent inspection, at every terminal, while other roads make the Class A inspection at the originating point, and a Class B, or running inspection, at passing terminals, the latter, of course, being used more ex-

tensively by roads that are able to operate main-track freight trains. A car that has been given a 100 per cent inspection, with the boxes properly packed and oiled, at the originating point will travel to its destination without further servicing, whether the distance be 500 or more miles.

On some roads, where coal is the predominating commodity, the loaded cars are given Class A inspection at the first classification yard where the cars are assembled or classified for trains for movement over more than one division. They are given a Class B inspection at intermediate terminals, and are run a distance of 230 miles or more, where they are delivered to connecting lines. It is only rarely that a car is cut out of these trains while en route. These roads, in handling fast freight, use the same method of inspection; however, they are not quite so successful in improving the cut-out bad-order situation as they are on the coal trains, due primarily to the fact that foreign cars are handled which are not maintained to the same standard.

These facts are mentioned to bring out the point that were each individual railroad to have the same standard or system of maintenance of equipment, it would be possible to move loaded cars from the Atlantic to the Pacific, and from the Great Lakes to the Gulf of Mexico, without the necessity of bad ordering cars, except for certain defects which develop in transit. A good inspection before the car is loaded will show whether or not the car is in condition to take the load to its destination and, if not, what must be done to place it in condition for satisfactory service. Every time a loaded car is cut out in bad order at a terminal it means a delay to that car, and if the train is held for repairs to be made to the car it will cause serious delays to other cars.

Another Aspect of Defense Transportation

In these columns last month were discussed several phases of the freight-transportation problem likely to arise as the result of the large-scale program for national defense on which the nation is now entering. This had to do with the material aspect of the program. It is now evident that we will soon hear more about the personnel aspect of the program when Congress has taken final action on the various proposals for compulsory military training, National Guard mobilization and reserve officer mobilization which are now before it. Whatever immediate action it takes, it is evident that ultimately we shall have to provide for the movement of draftees to training camps and, if worse comes to worst, for the mobilization of troops in armies at strategic points for the defense of the territory of the United States.

During the fourteen months up to November 1, 1918, the movement of troops of all kinds for the War Department amounted to an estimated total of 4,440,000,000 passenger miles. This was 8.6 per cent of the total passenger mileage for the period which was estimated at 51,500,000,000. About one-quarter of the military passenger miles were produced in the movement of drafted men to training camps and three-quarters in movements intercamp and from camps to embarkation points. From May, 1917, until the armistice in November, 1918, the entire training and mobilization period, the average monthly movement of troops amounted to about 503,000, with a maximum of 1,147,000 in July, 1918.

This was the movement required to create and embark an army of two million men. It required a total transportation of upwards of 8,700,000 men, involving 222,500 passenger-train car trips and 16,300 freight-train car trips in 16,500 trains.

These car requirements are the totals for a period of 18 months. About one-eighth of the total, however, was concentrated in the peak month. The same monthly peak load added to the 1938 passenger movement would represent an increase of more than 50 per cent in passenger miles but, owing to the greater average number of persons per car, the increase in passenger-car miles would probably not greatly exceed 12 per cent.

This can be considered only a rough approximation inasmuch as the average amount of mechanical equipment to be moved per man has increased materially under present conditions as compared with those prevailing at the time of the World War. It will also have to be corrected for whatever increase in the proportion of the total movement there may be on the highways. And it must be remembered that this was the peak month in the mobilization of an army of two million men following the declaration of war. As far as can be seen at the present time, the initial mobilization will be considerably less than two million and probably will be pushed much less intensively until we become directly involved in the conflict. Furthermore, until there is actual warfare, the movement will be confined to the collecting of men in training camps and this accounted for only about one-quarter of the total military passenger miles created by the training and embarkation of our World War army.

One Form of Training For Locomotive Supervisors

When a nation prepares to defend itself against a coming struggle there are certain steps that must be taken, under intelligent leadership, before any real program of defense plans can be carried out. Funds must be appropriated and expended, and officers and men enlisted and trained and equipment built and maintained in service. Until these things are done there is no defense and when they are done an adequate defense exists only as long as the plan of action is perpetuated.

On the railroads of the United States there are several "armies of defense"; those who operate and maintain the locomotives, cars, shops and enginehouses. The largest of these is that group of men whose duty it is to provide the motive power that moves trains. It may be interesting, at a time when the nation is talking and thinking about man power and equipment, to record the fact that the locomotive departments are responsible for some 43,000 steam locomotives, 800 Diesel locomotives and 770 electric locomotives; that in order to do the job with which they are confronted the "army" is in command of more than 2,000 key men and an "enlisted personnel" of approximately 150,000 men; that, in the year 1939 it spent $263,000,000 for repairs to locomotives—and $487,000,000 more was spent for wages fuel and supplies to operate them.

Outside of the general officers on the various roads the principal supervisors in the locomotive department are in the following classifications: superintendent of shops, master mechanic, mechanical engineer, shop engineer, supervisor of shop machinery and tools, assistant shop superintendent, general foreman of locomotive repairs, general enginehouse foreman and supervisor of apprentices. These are the key men—approximately 2,000 of them—upon whom falls the burden of the responsibility of carrying out the details of the policies and plans for the spending of 263 million dollars a year—an average of $130,000 a year per man. How well are they trained for such a job?

One of the remarkable things about the railroad industry is the loyalty and efficiency of supervisory organizations that have grown up into the jobs they occupy by way of the hard road of experience and long hours. Railroad management, particularly in the past 10 years, has made little or no special effort to provide a systematic course of training for the men who are the backbone of its army of defense but, in spite of many handicaps the supervisory organizations have come through thus far with an enviable record and again stand ready for any duty that the future may bring.

In the absence of regularly organized training courses for supervisory personnel there is available a means of supplying the deficiencies that may now exist in the broadening education of these key men in matters pertaining to the most expensive operation in the railroad job—locomotive maintenance. That means is the influence of membership and committee work in an association the objectives of which are the advancement of knowledge contributing to increased efficiency in the field of loco-repair work. The Locomotive Maintenance Officers' Association is such an organization and the progress that has been made by that small group of officers and "charter" members in bringing the association up to the standard of program and attendance that it attained last October is deserving of the support of every railroad supervisor eligible for membership, and of every general mechanical officer within whose jurisdiction rests the authority to send his supervisors to the meetings of the association.

Rapidly changing events have driven home to us as never before the value of unified action in order that the individual abilities of men may be used collectively toward a common end and associations such as this provide the means of acquainting a membership scattered over the entire country with the objectives that are so important in fitting it into the defense plan.

New Books

TURRET LATHE OPERATOR'S MANUAL. *Published by the Warner & Swasey Company, Cleveland, Ohio. 240 pages, illustrated. 7 in. by 10 in., bound in cloth. Price, $2.50.*

This book is published to serve as an instruction manual for the training of turret-lathe operators and to enable present operators to improve their operating technique, the quality of their work and to do the job with greater efficiency. It is written expressly for the shop man and the text is supplemented by over 350 illustrations and drawings. The manual contains 25 chapters which are grouped so as to present a classification and description of the types of turret lathes and their equipment; a descriptive analysis of the operations which they perform; the special fixtures and tooling equipment used; the principles of turret-lathe tooling; examples of bar and chucking work; a chapter on the principles involved in estimating production and a data section containing such information as is usually needed by operators of this type of machine. Having absorbed the information in the first 18 chapters of this manual the railroad-shop operator of a turret lathe will recognize in the next five chapters—those dealing with bar and chucking equipment and problems and special tools—many of the answers to specific questions on railroad operations which come up in the course of a day's work. A study of this manual by operators and supervisors of machine work can hardly fail to result in getting more out of the equipment they use.

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE. *Sixth Edition. Published by the Lincoln Electric Company, 12818 Coit Road, Cleveland, Ohio. 1,125 pages, illustrated. 5¾ in. by 9 in., bound in simulated leather. Price, $1.50.*

The eight sections of the handbook cover Welding Methods and Equipment; Technique of Welding; Procedures, Speeds and Costs for Welding Mild Steel; Structure and Properties of Weld Metal; Weldability of Metals; Designing for Arc-Welded Steel Construction of Machinery; Designing for Arc-Welded Structures, and Typical Applications of Arc Welding in Manufacturing, Construction and Maintenance. Several pages of the latter section are devoted to railroad equipment. While some of the applications therein described cannot be recommended as good practice, possibilities of the use of arc welding in the railroad shop are suggested.

Lehigh Valley Converts

Hopper Cars for Cement



DURING the month of May the Lehigh Valley started a program calling for the conversion of 25 hopper cars of 70 tons capacity to covered hoppers of the same weight capacity for the handling of cement and similar commodities. The first of the converted cars came off the assembly line at the Sayre, Pa., shops and was turned over for service during the week ending May 18.

The original cars, as they come to the shop for rebuilding, were similar in design to those described in an article in *Railway Mechanical Engineer* for October, 1938, page 392. That article described the processes involved in the cutting down of the cars from hoppers of 70 tons capacity to 50 tons capacity. In that case 11 ft. 8 in. were cut out of the center of the car and the shortened car was welded and riveted together to form a finished car having a light weight of 40,600 lb. and a

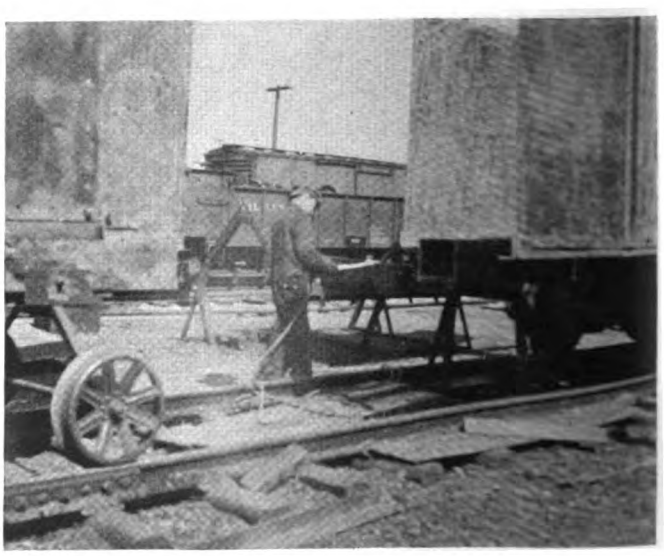
Principal Dimensions and Weights of the Lehigh Valley Cement Hopper Cars

	Series 50,000-50,089	Series 50,100-50,149	Series 50,150-50,174
Length over strikers, ft.-in.	31-6	41-6	33-5½
Length, inside, ft.-in.	30-0	31-7½	26-3⅝
Width inside, ft.-in.	9-5½	9-6¼	9-6¼
Width overall, ft.-in.	10-0¾	10-2	10-1½
Height rail to top of side plate, ft.-in.	10-3 13/16	10-6	12-0⅞
Center to center of trucks, ft.-in.	21-9	31-6	23-5½
Truck wheel base, ft.-in.	5-6	5-8	5-8
Capacity, lb.	100,000	140,000	140,000
Capacity, cu. ft.	1,393	1,933	1,790
Load limit, lb.	124,500	153,900	156,900
Light weight, lb.	44,500	56,100	53,100
Ratio revenue to gross load, per cent	95.1	106.7	96.9
Ratio revenue to load to tare weight, per cent	266	292	286

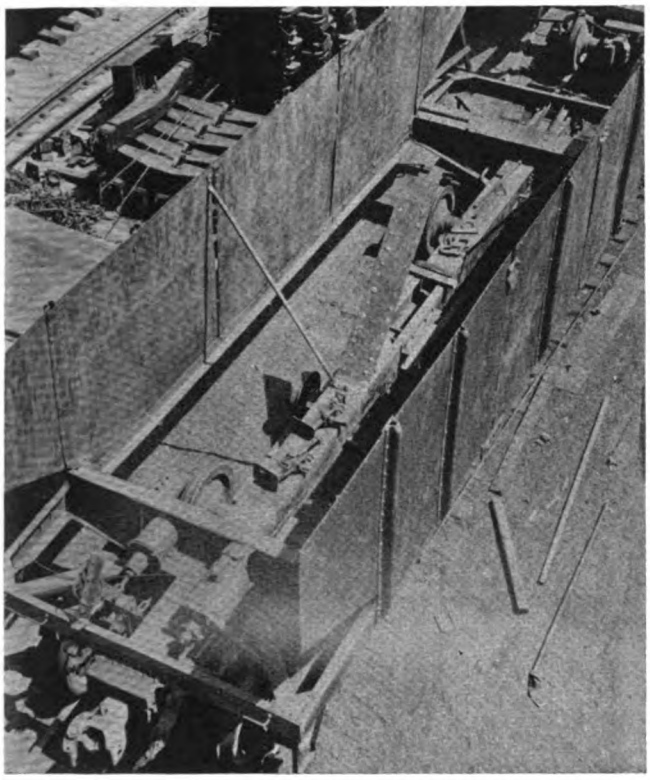
NOTE:—Based on 85 lb. per cu. ft. weight of cement.



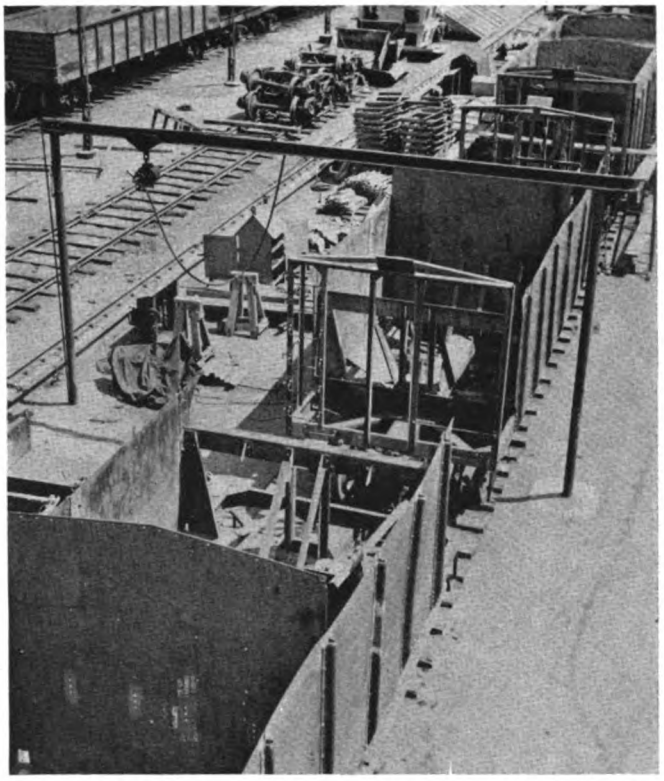
Preparatory to shortening the cars side panels are removed and a center sill section is cut out—The ends are supported on a dolly



The method of supporting the car ends is shown—The workman is cutting out the side sill section before pushing the ends together



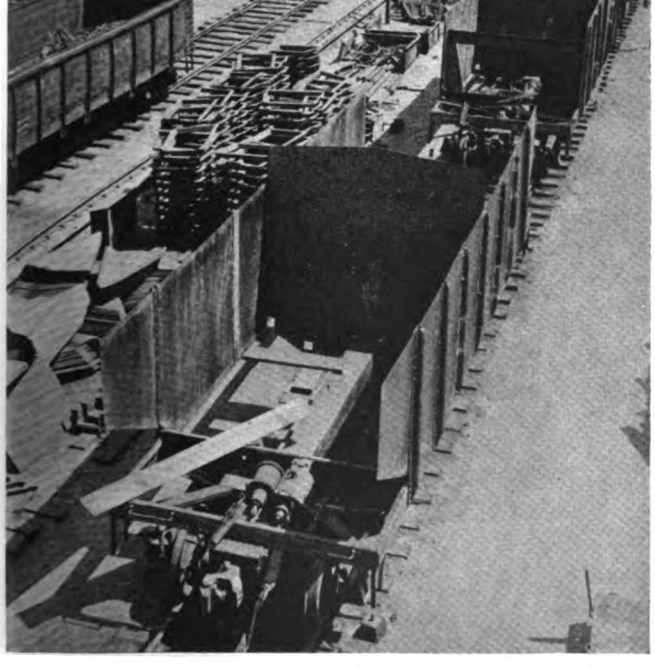
This and the following six photos were taken from the overhead crane The car is ready for removing panels and cutting sills



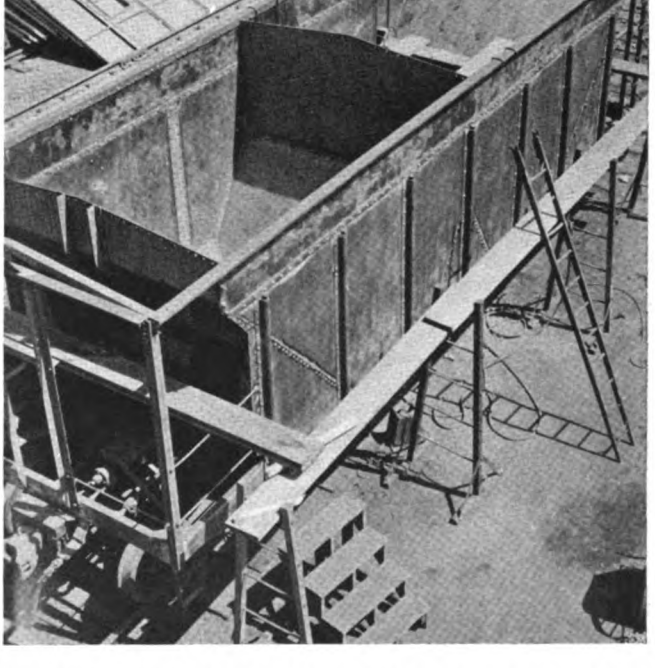
Here the cars have moved along the assembly line to the position where the end framing is applied by the aid of an overhead hoist

cubic capacity of 1,928 cu. ft. In the rebuilt car for cement service, described in this article, 8 ft. 0½-in. is cut from the center of the old car, shortening the over-all length of the car to 33 ft. 5½ in., over the striking plates, and 23 ft. 5½ in. truck centers. These cars are of the former 40,000 series and the rebuilt cars are being numbered from 50,175. The cubic capacity of the cement cars is 1,790 cu. ft. and the light weight is 53,100 lb. The principal weight and dimensions of Lehigh Valley cement cars is shown in the table.

The rebuilding process is carried out in the open freight car heavy repair yard at the Lehigh Valley's

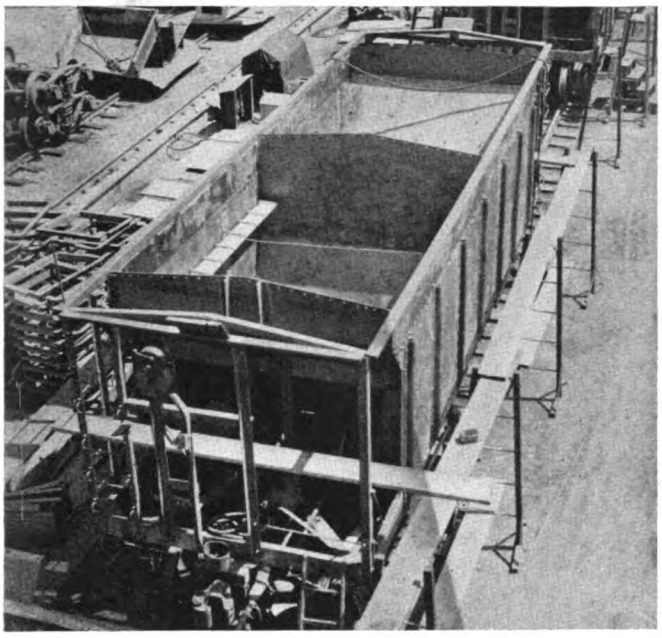


At this position the center partitions have been installed and the straightened side stakes have been returned and applied to the car



The 21-inch extension has been added to increase the height of the car, the top side and end bulb angles and slope sheets applied

system shop at Sayre. Numerous improvements in repair facilities have been made at this point during the past two years such as the equipment of the yard with a 100-ft. gantry crane on a 700-ft. runway, the piping of the working area for acetylene and the installation of electric welding circuits with a central motor-driven welding generator set. A comparison of the illustrations accompanying this article with those appearing in connection with the article describing the converted hoppers previously mentioned will reveal the greatly improved facilities which now permit greater output.

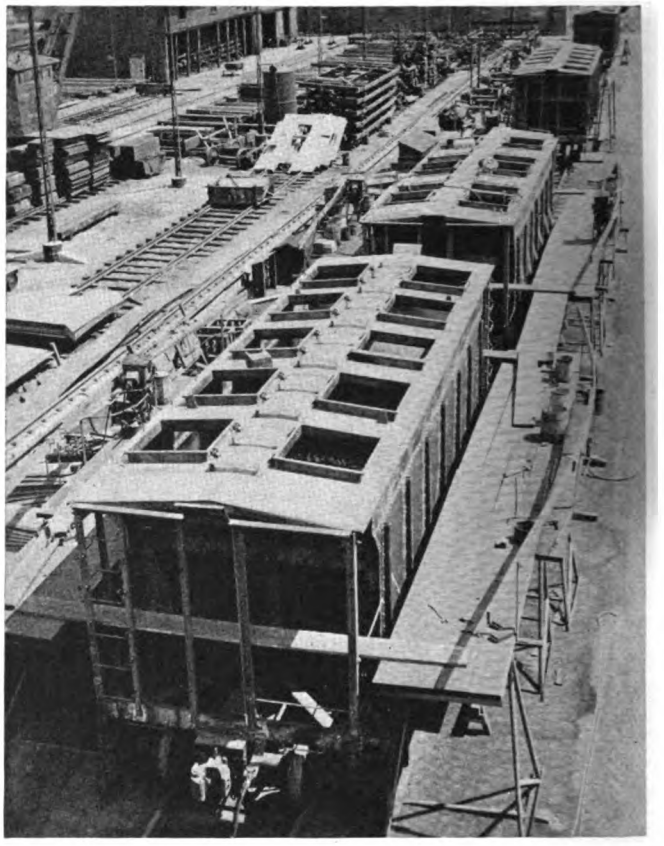


Couplers, draft gear and hand brake have been applied

In the rebuilding operations the old cars are brought into the north end of the repair yard and move in a straight line, on the same track, toward completion. In the stripping position all of the burning is done with acetylene torches to remove the rivets from the bulb angles, slope sheets, hoppers, and side and end sheets. In this position the necessary burning is done to remove the two side sheet panels, one from each side of the car, preparatory to cutting out the 8 ft. 0½ in. from the center of the car. On one side of the car one sheet is removed from the center toward the "A" end of the car and on the other side one sheet is removed from the center toward the "B" end of the car. Thus, in the completed car the cutting and splicing of the side members has been done diagonally across the car.

After the burning has been completed all of the parts above mentioned are broken out and disposed of and the cars are sent to be sandblasted, after which they are given a coat of rust preventative before they are returned to the rebuilding tracks.

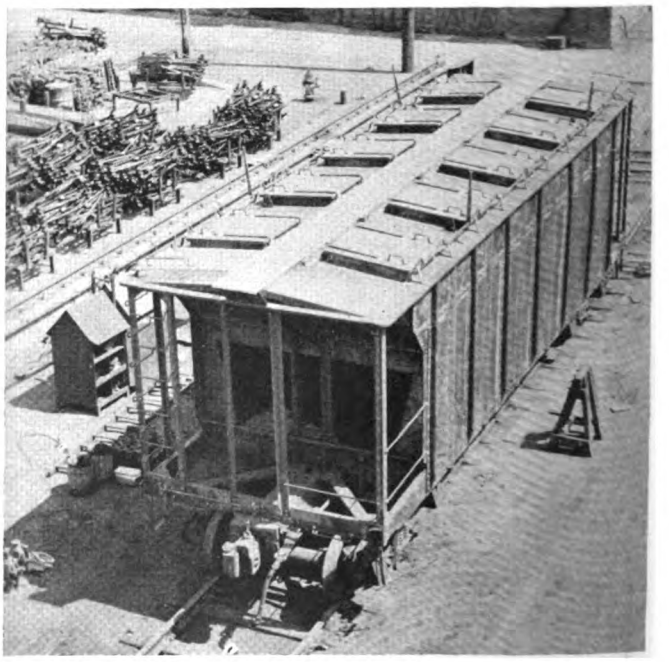
The next job that is necessary is the cutting of the center and side sills. This is done with the torch and the center sill cutting is done with the aid of a jig to facilitate the channels being cut accurately. The side members are cut out between the side sheet panels that remain after two panels on each side have been removed. One of the illustrations shows how the center sill ends are supported with one fixed and one movable support before the section is cut out. After the cutting is finished the ends of the center and side members are chamferred, by grinding, preparatory to the welding operations involved in the splicing. The end of the car



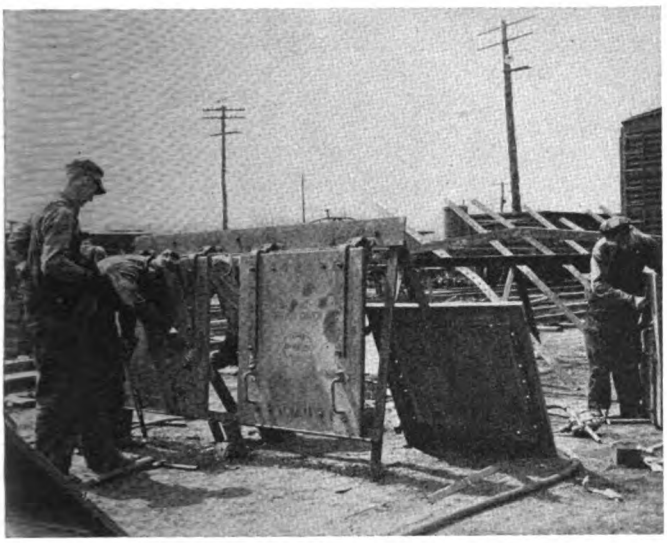
The roofs with hatch openings have been put on and seal welded

to which is attached the movable support is then pushed ahead until the cut-out section is closed in and the splice plates are welded on the center sill channels, the center sill cover plate is fastened down and the splice plates are welded to the side sills.

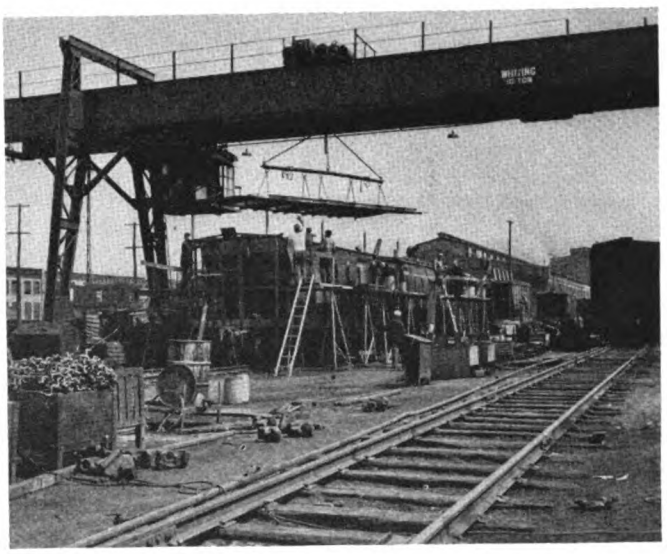
During the stripping operation it is often necessary to remove some of the original pressed steel side stakes and have them straightened. It is at this stage of the rebuilding job that these are returned and replaced on



Here the hatch covers and locks are on and the car is ready to paint



The hatch covers are made on jigs—These jigs are used in a vertical position which facilitates the drilling and reaming



After the roof is completed on one of the two roof jigs it is lifted over to the assembly line by overhead crane and this fixture

the shortened cars, two of these side stakes forming the splicing members for the side sheets on either side of the car. It is of interest, at this point, to call attention to the fact that a 21-in. extension is added to the top of the car sides to increase the height. At this stage, before this extension is added, there are seven of the original side stakes on each side of the car and these end at the top of the original side sheets. These original side stakes are later extended and new side stakes added at the time the extension is applied.

The cars are now moved to the next position where the center partition is installed and the bolster reinforcing plates are welded on. At this position the reinforcing angles for the slope sheets and cross ridge sheets are applied and following this the supports for the slope sheets and hopper sheets are installed. At this same position the hopper door frames and doors are secured to the hopper sheets and made ready for the welding operations that seal up the joints around the door frames.

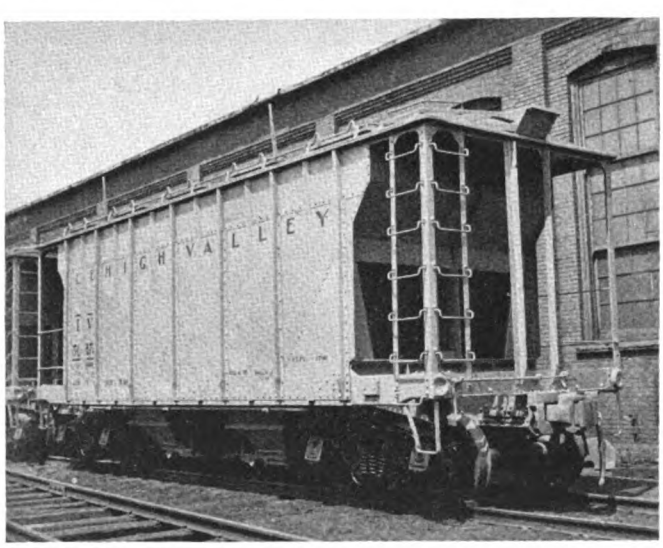
The "A" and "B" ends of the cars are made on jigs at an adjacent location and are now brought to the building track and applied to the cars. At the same position the bulb angles at the ends of the cars are applied.

In the next position the extension at the tops of the car are placed and riveted to the original side sheets and the top side bulb angles are put on, reamed and riveted to the side sheet extensions and to the car ends. The four slope sheets are installed and tack welded in place.

The cars are now moved to the next position, the roofs are lifted over from the roof jigs to the assembly line and placed in the cars, where they are fitted and reamed preparatory to riveting up. In the next position the hatch covers, cover locking devices and runboards are applied and the cars move to the position where the welding is done. Here the seams between the roof and the sides and ends are welded; all of the inside seams are welded, electrically; the seam between the original side sheets and the top extensions are welded; new pressed steel intermediate side stakes are welded onto the outside of the side sheets between the original side stakes and the extensions to the original side stakes are welded on. At this position the hopper door frame joints are welded to provide sealed hoppers.

Jigs are utilized to assemble the car ends, roofs and hatch covers. Two roof jigs have been installed adjacent to the assembly track. One of these jigs is used for fitting up a roof while the finishing work is being done on the other jig. The jig for the hatch covers is used for the application of the hinges. The hatch cover locking device, consisting of a long round bar supported in bearings, is made on a hydraulic press in the blacksmith shop. When the handles are in the closed position they are secured by handle locks and the two bent projections in the bar bear on each of the hatch covers and hold them in place.

The cars reach the truck repair position with the original trucks. The old trucks are removed adjacent to an elevated truck-repair track and trucks that have been overhauled are placed under the cars. When the cars reach this position the draft gear, couplers and brake equipment have been applied and the cars are then given a thorough water test before they are moved on to the painting position.



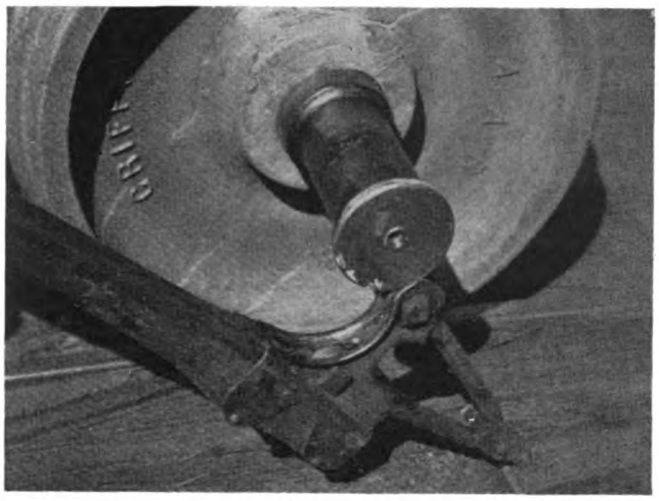
The first of the rebuilt cars is completed ready for service

After the cars are dry a second coat of rust preventative is sprayed on and this is followed by two coats of battleship gray paint. The lettering on the cars is done in black by the brush method.

Wheel Stick Designed To Eliminate Journal Damage

Although the wheel stick is employed in most railroad shops in the handling of mounted wheels, it is a tool that can cause considerable damage to the journals if not properly designed and used. For this reason considerable study was given to the design of the wheel stick shown in the illustration. It consists of a long wooden handle with a steel frame fitted to its lower end having a single steel rod projecting about 6 in. below the end of the handle. Between the side plates of the steel frame are two rollers of sufficient width to allow the end collar of the axle to drop down between the side plates and rest on the roller surfaces.

In handling wheels, the stick is hooked under the end collar, allowing the collar to rotate on the rollers. This eliminates any damage that might be caused by the use of a wheel stick under the journal.



The wheel stick is hooked under the end collar

Bucking Bar for Steel Car Work

A convenient type of bucking bar, known as the 9-bar, because of its similarity to the figure nine, is shown in various stages of manufacture in the illustration. The Farlow draft-gear link shown in the foreground is cut into two parts, as illustrated, and a small piece cut out near each end, so that from one Farlow link two pieces of steel are secured which have roughly the desired shape of the bucking bar. Two completed bars with rivet headers formed on one end and the handle end drawn out slightly at the other, may be seen in the background of the illustration.

This type of bucking bar is well designed for use in applying pressure to the head of a rivet inserted through relatively thin steel sheets. The short straight arm of the bucking bar, in line with the handle, is simply placed over the two steel sheets or shapes to be riveted together and the header forces the rivet through from the other side. On account of the large leverage, relatively little pressure on the handle of the bar will pull the sheets together and hold the rivet head securely while it is being upset with an air hammer. This bucking bar is light in weight, easy to handle and can be used to advantage in close quarters. It can be readily designed and forged to any desired shape, dependent upon the special requirements of individual bucking jobs.

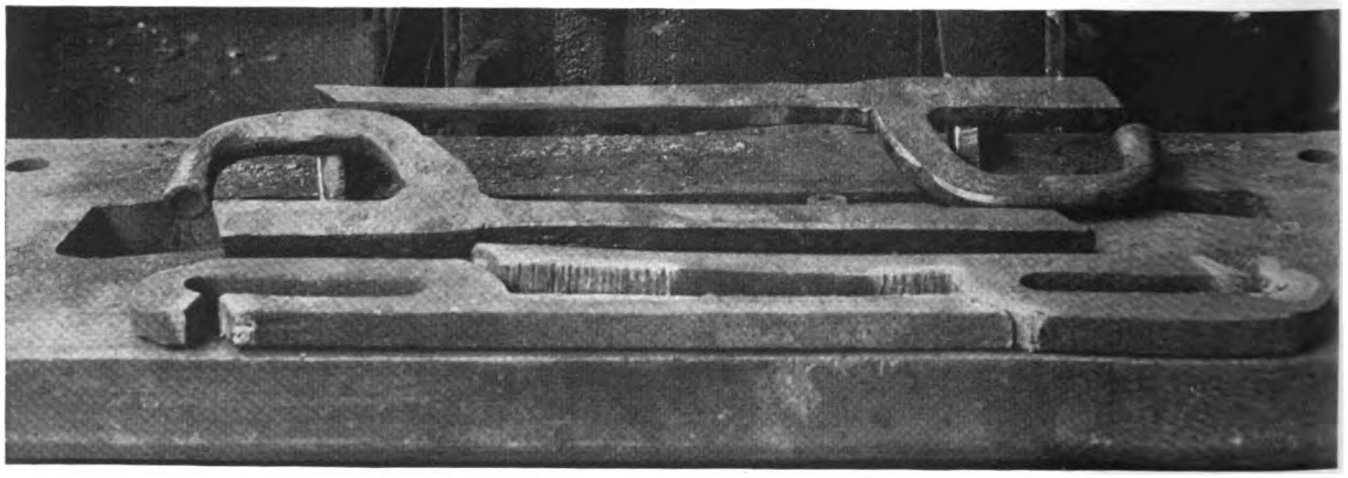
Air Brake Questions and Answers

D-22-A Passenger Control Valve (Continued)

585—*Q.—How should the piston ring and bushing be lubricated?* A.—Before the cleaned piston is replaced in the bushing press the side of the packing ring opposite the scarf to the bottom of the groove, then introduce three drops of approved triple valve oil in the groove through the scarf opening, after which restore the ring to its normal position and carefully rotate it in its groove to distribute the oil. Next, place three drops of the triple valve oil in the bushing and distribute it over the entire surface in a manner to avoid introducing dirt or other grit. Then insert the piston and slide valve in the body, leaving them in release position, after which place three drops of triple valve oil in the cylinder bushing and again distribute it on the bushing surface as previously described.

586—*Q.—What do the preceding instructions also apply to?* A.—The release piston and its slide valve.

587—*Q.—How should the emergency portion be cleaned and lubricated?* A.—When the emergency portion is to be dismantled and cleaned, the main piston cannot be removed without first removing the upper



Two bucking bars made from a scrap Farlow draft-gear link

cover and taking out the diaphragm strut, which serves to hold the slide valve to its seat. Damage will result if force is used to remove the emergency piston from its bushing without first removing the diaphragm strut. The spring behind the emergency vent valve is held in place by a circular sheet metal retainer which has lugs on two opposite sides. These lugs engage under a lip around the outer end of the cavities in the body casting. To remove the spring and valve, press down on the spring retainer and tilt it so that one lug is exposed upward. When in this position, the parts can be readily removed and they can be re-assembled by the same method. The individual parts of the emergency portion, such as pistons, rings, valves, springs, and gaskets, must be cleaned and inspected in the same manner as was specified for similar parts of the service portion.

588.—*Q.—How can the type UA brake cylinder be lubricated without dismantling?* A.—Remove the upper ⅛-in. pipe plug from the pressure end of the cylinder. Attach an approved pressure gun to the connection and inject about 2½ cu. in. of brake cylinder lubricant. Replace the ⅛-in. pipe plug at the outer end of the non-pressure head. Attach the pressure gun and inject about 1¼ cu. in. of brake cylinder lubricant, which will lubricate the piston rod bearing and dirt protection seal in the non-pressure head. Replace the ⅛-in. pipe plug.

589—*Q.—When should the brake cylinder be dismantled for inspection, cleaning, repair and lubrication?* A.—At the periodical cleaning period for the equipment or when the cylinder has been lubricated by means of a pressure gun and check test shows objectionable leakage.

590—*Q.—What is the method recommended for cleaning and lubricating when the brake cylinder is to be dismantled?* A.—It is recommended that cleaning and reconditioning the piston and non-pressure head assembly be done in a clean room where special tools for this purpose are available, and the work can be done without possibility of damage to the parts which might occur if this work is attempted at the car. Protection against dirt should be provided during the movement of these parts from the repair shop to the car, and care exercised to keep dirt from the piston when applying it to the cylinder.

591—*Q.—How should the packing cup be removed and cleaned?* A.—Remove the packing cup by using a wooden tool about 1 in. wide and 3/32 in. thick or equivalent, having rounded edges to prevent damage to the packing cup and the piston lubricator. The packing cup should be thoroughly cleaned with an approved solvent to aid in removing the oil, grease, and dirt, then inspect for cracks, damage or worn out condition.

592—*Q.—How should the piston lubricator and its swab be cleaned?* A.—The piston lubricator with its swab should be cleaned without removing the felt from the ring, submerging the ring in a tank of specified solvent for a few minutes, then loosen the felt in its groove with a thin rounded-edge blade, after which the ring should again be immersed in the solvent for a time sufficient to dissolve the grease from the felt. Brushing the outer surface of the felt with an ordinary hand brush will aid in removing the old grease and clean the surface of the felt. The felt should then be dried with a jet of air.

593—*Q.—When and how should a new lubricating felt be applied?* A.—When the felt of the piston lubricator is damaged, worn out, or in such a condition that it cannot be loosened and raised in its groove so as to make full contact in a ring gage which should be provided for this purpose, the felt must be removed and replaced by a felt in good condition. Next, submerge the assembled felt retainer ring in a tank of specified oil, the tank being of sufficient depth to cover a number of these assemblies. The felt retainer ring should be soaked in oil for at least 10 minutes and allowed to drain for the same period of time. The object of this operation is to saturate the felt and thereby prevent it from absorbing oil from the brake cylinder lubricant. The felt retainer ring is now ready for application to the piston.

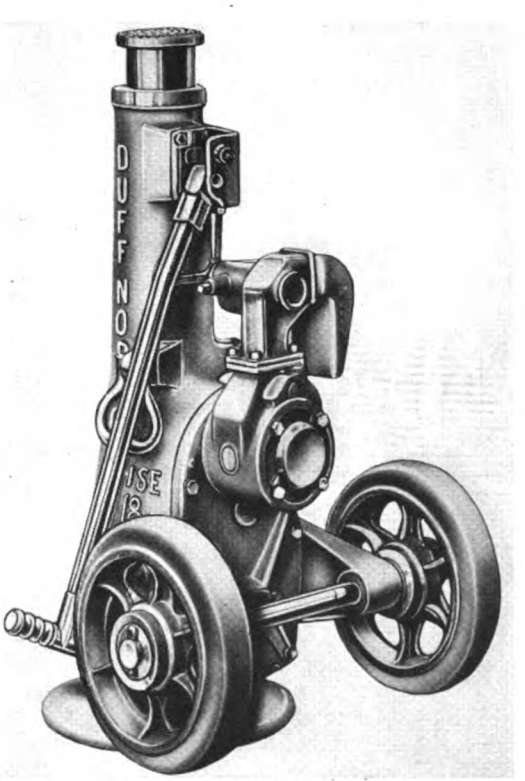
594—*Q.—How should the piston lubricator assembly be applied to the piston head?* *A.*—To the piston with the flat (felt) side next to the piston.

595—*Q.—What is the purpose of the side vent in the brake cylinder cut-out cock?* *A.*—With the cock closed, the side vent drains air pressure from the brake cylinder and the brake is positively released. This makes it possible to cut out the brake as covered by the previous answer without possibility of the cut-out brake "creeping on" for any reason. It also provides for safely changing brake shoes or adjusting piston travel.

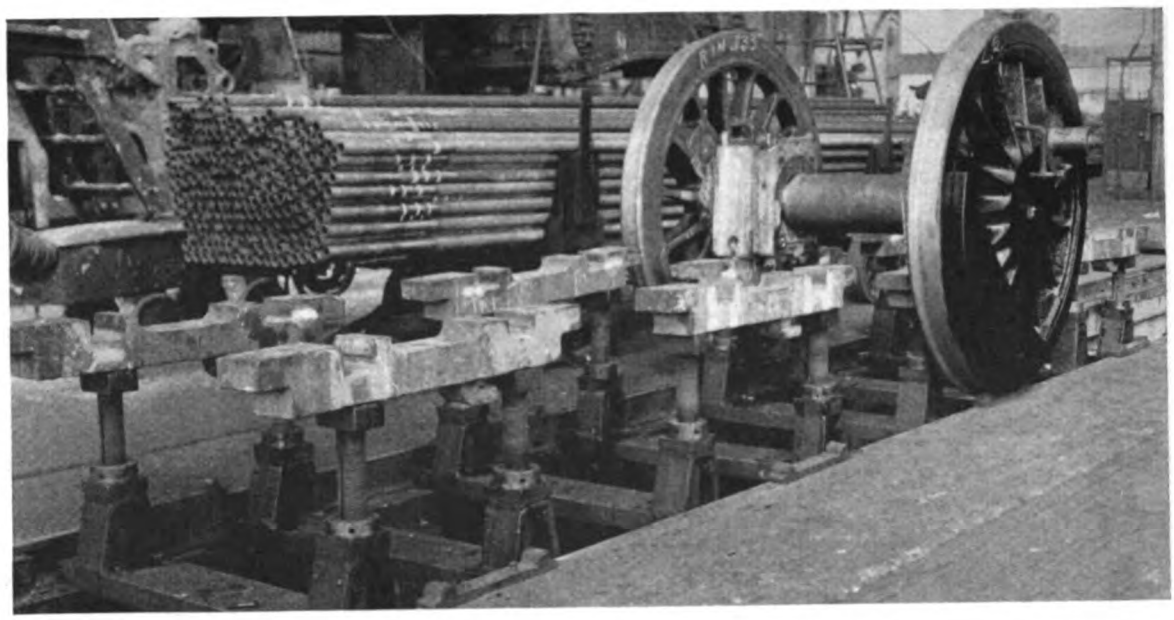
Motor-Operated Jack for Empty Freight-Car Work

A 20-ton jack, operated by a rotary air motor and designed for empty freight-car repair work, has been added to the line of jacks made by the Duff-Norton Manufacturing Co., Pittsburgh, Pa. By using two of these jacks, one man can raise and lower a car 18 in. in 4.3 minutes. When operating two jacks in this manner by using a Y-valve connection, the accurately timed lifts permit the car to be raised evenly up to the limit of 18 in.

The jack is mounted on roller-bearing wheels having rubber tires and is easy to move and place. As a safety feature, the motor is stopped automatically when the lifting standard reaches the safe limit of its raised or lowered position. The jack operates on standard shop air pressure.



The Duff-Norton 20-ton jack for empty freight-car repair work is operated by a rotary air motor

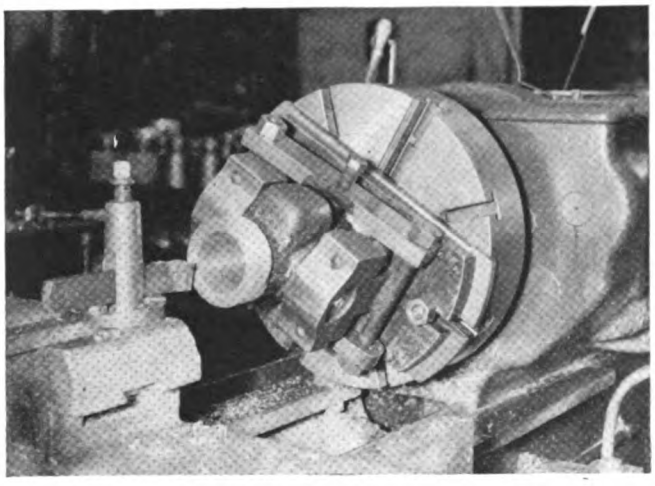


Equipment used in wheeling locomotives at Paducah shops

Paducah Shop

Jigs, Fixtures and Devices

By G. H. Raner*

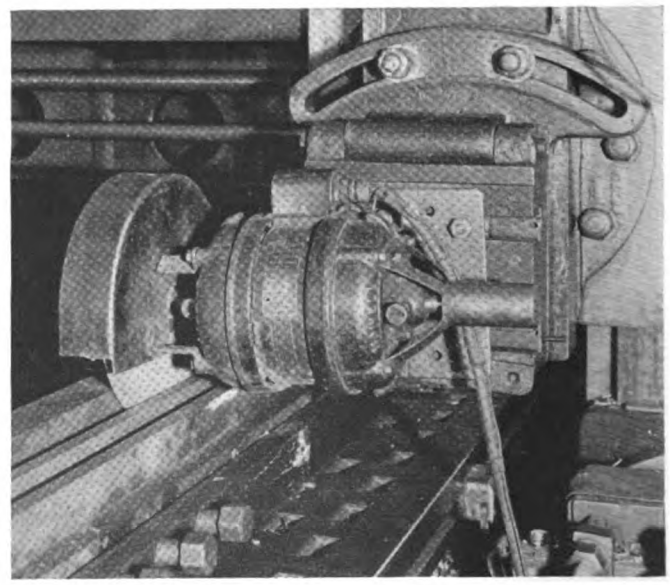


Jig for holding radius-bar guide while being machined

THE following description of special jigs, fixtures and devices now being successfully used at the Paducah (Ky.) locomotive shops of the Illinois Central is a continuation of an article on the same subject published in the June, 1940, *Railway Mechanical Engineer.*

Wheeling Locomotives

An arrangement for properly spacing all driving wheels, and supporting frame binders for wheeling locomotives is shown in one of the illustrations. Spacers for wheel arrangements of various classes of engines are available, the set needed being placed on top of the rails, as illustrated. Two holes are drilled in each spacer to receive pins which engage suitably spaced holes in the track rails. The driving wheels rest on the spacers which definitely position them the correct distance apart and square with the track. The crossbeams for holding the binders are pieces of 12-in. channel iron, reinforced on the inside by a piece of flat iron welded in the channel and resting on the concrete ledge of the pit. The adjustable screws shown are 3 in. in diameter by 24 in. long, this height permitting adjustment to accommodate all classes of locomotives. It will be noted that the



Method of truing multiple-wear guides by grinding

* Assistant shop engineer, Illinois Central.

screws extend down through the cross channels and a key way in each adjusting screw prevents it from turning when raised or lowered by the round nut. The head is welded on top of the screw.

The driving wheels are placed on the spacers with boxes already applied. Frame binders are then placed on the fixtures and raised to a height to conform to the engine. Frame wedges are set in place on the driving boxes. Shoes are placed on the frame of the locomotive itself and held by set screws at the top of the flange on the inside. When all wheels are in place with binders and wedges set, the engine is lifted by an overhead crane and lowered down over the wheels. The jig arrangement is set by the adjustable screws to the proper height so that the weight of the locomotive forces the pedestal legs into the binder jaws.

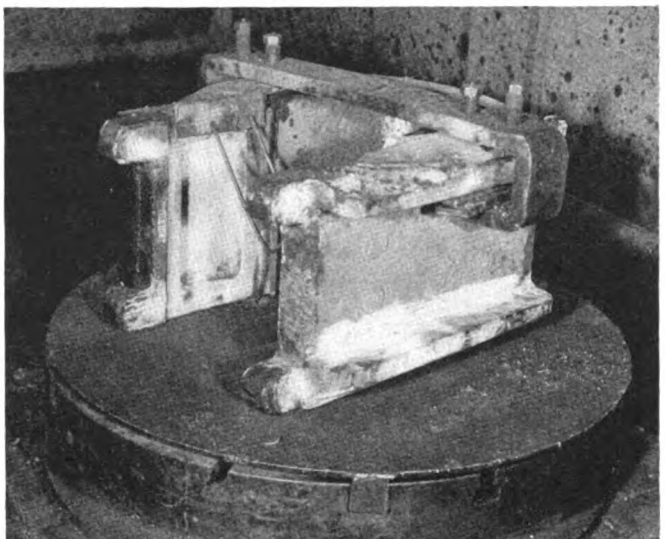
Radius-Bar Guider Holder

The base of the jig for holding radius-bar guides while machining in an engine lathe is ¾ in. by 9 in. wide, being counterbored and made of such a length as to suit the machine chuck on which it is used. It is held in place on the chuck by two ⅞-in. T-bolts. Two removable caps are bolted to the base plate for holding the guide and there are also two removable clamps for adjusting the back end of the guide by means of set screws. This holding device is used for both turning and boring these radius-bar guides which are difficult to hold in an ordinary machine chuck, as they are only 10 in. long and somewhat irregular in shape. By the use of this jig, four of these parts may be completely machined in an eight-hour period, which is about four times the production possible by former methods of machining.

Truing Worn Multiple-Wear Guides

One of the devices illustrated is a 2-hp. motor and grinding wheel operating at 1,800 r. p. m. and attached to a Betts planer tool head for use in truing worn multiple-wear guides. The abrasive wheel used is a Norton wheel made for grinding steel and is of a size most suitable for the particular operation of smooth finishing. The guide is held in place on the planer by a special fixture and the machine table moves at 20 ft. per min.

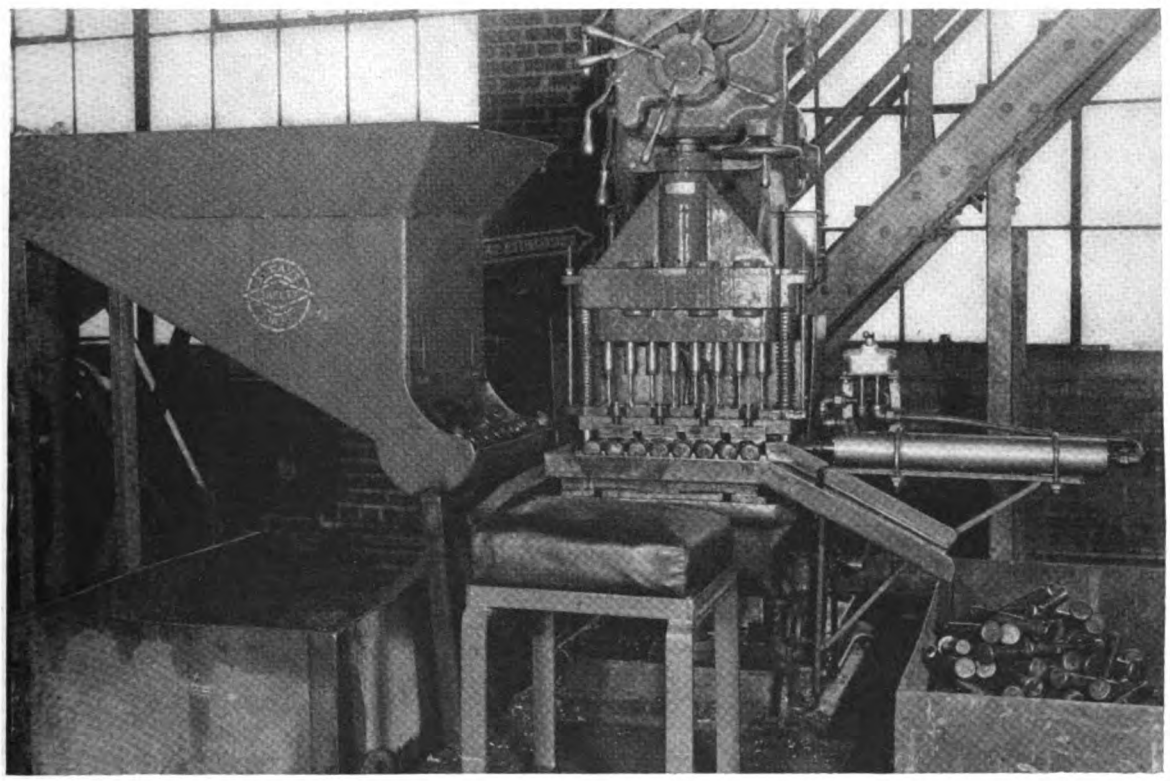
In the absence of such an arrangement for smoothly grinding multiple wear guides, it would be necessary to file and polish by hand; a slow and laborious operation.



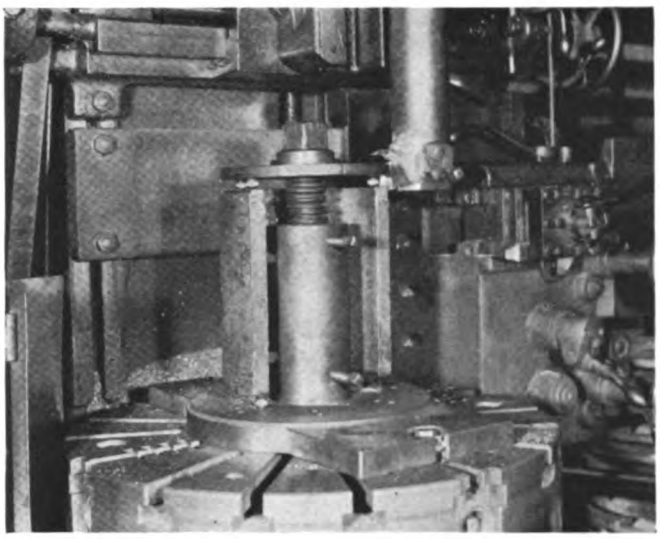
Rotary support for driving boxes and other locomotive parts while being welded

Multiple Drilling Operations

A Hoeffer multiple drill, which is used primarily for drilling brake- and spring-rigging pins, eight at a time,



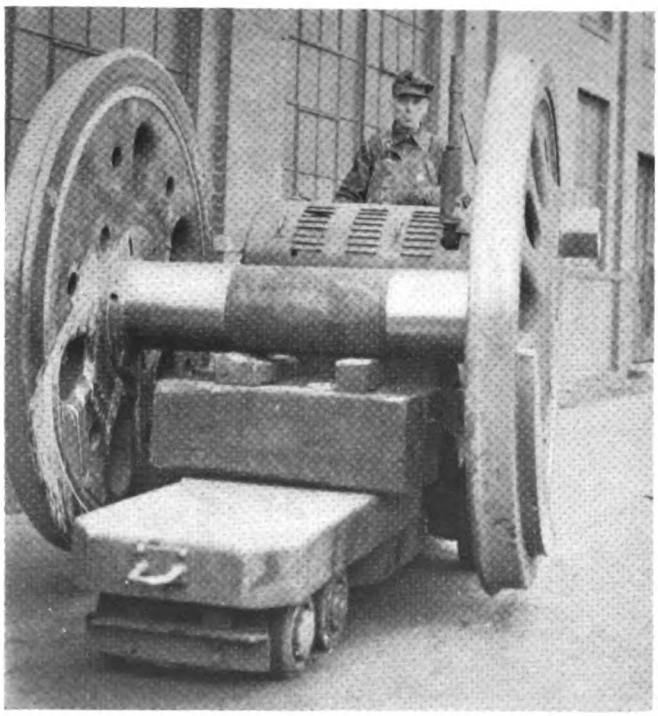
Hoeffer eight-spindle machine for drilling brake- and spring-rigging pins



Jig for holding crown brasses on a Bullard vertical turret lathe while being machined

is illustrated. These pins are held in place by a special fixture, which serves to hold them while all holes are automatically drilled a correct distance from the head of the pin. When the drilling operation is completed on each lot of eight, they are automatically removed by an extractor, which is controlled by an air-operated 3-in. cylinder not visible in the illustration, but located on the opposite side of the machine and operated by a foot pedal. This serves to dump the eight pins in the pan in front of the machine. From thence they go into the skid box.

The supply of undrilled pins is carried in a hopper, where they move down by gravity within easy reach of the operator for placing in the machine. As many as 1,800 pins may be drilled by one operator in a period of eight hours.



Lift-truck and blocking arrangement used in moving driving wheels without danger of scoring the journals

Supporting Main Driving Boxes for Welding

Another illustration shows a revolving table or face plate used for supporting many locomotive parts while being welded, but primarily for welding hub liners to main driving-wheel boxes. The table consists of an old drill-press table mounted on a spindle with ball bearings, set in the shop floor and having a sheet metal top which supplies a smooth surface for supporting the work. This device is easily revolved by hand to whatever position is most convenient for the man who is doing the welding.

Holding Locomotive Brasses for Machining

The device for holding a locomotive crown brass while being machined consists of a base as illustrated, made of forged steel 1½ in. by 15 in. in diameter and having



Air-operated door-opening device as used at Paducah shops

an extension fitting into the Bullard boring-mill table center which serves to hold the jig in alinement. The plate itself, as may be noted, is bolted to the table, one bolt on each side.

The cylindrical top leg of the jig is 6 in. in diameter and 10 in. high. It is welded to the base. In it are six set screws which are used for alining the brass from the inside. The top plate, drawn down tightly by the top nut as shown, has three pointed set screws to assist in holding the brass firmly. Similar set screws in the base also serve for adjustment purposes and to secure the

(*Continued on page 331*)

Flock of Troubles



He sat down at the desk in the office and began thinking aloud

by
Walt Wyre

JOHN HARRIS, roundhouse clerk for the S. P. & W. at Plainville, was looking through the mail, sorting it out and laying it in three piles. In one stack he placed correspondence that didn't require an answer, in another was routine inquiries about reports, etc., that the clerk could answer, the third and smallest pile was composed of correspondence that required the personal attention of the foreman.

Harris opened an envelope and removed a single sheet of paper. At the top of the page was typed "monthly allowance for May." The clerk glanced at the figures, then read them carefully and still couldn't believe what he saw even after reading them aloud.

"Say, Mr. Evans," Harris called to the roundhouse foreman who was in the little office adjoining, "we got the allowance for May."

"Is it cut any?" Evans asked as he came into the main office.

"Is it cut!" Harris echoed with emphasis. "Look at that!"

The foreman took the sheet of paper and read the figures. "There must be some mistake. Maybe the master mechanic's stenographer got the decimal point in the wrong place."

"That's what I thought when I first looked at it," Harris said. "Then I read what it said down at the bottom of the page:

"On account of business on the railroad being very bad through April and no prospects of improving, drastic reductions for May are necessary. No excuse will be accepted for running over the allowance. You will also arrange to store as many serviceable locomotives as possible in order to effect further savings. H. H. Carter, Master Mechanic.' "

"It can't be done," Evans said as he laid the letter on the desk, then added, "You might as well start working on a bulletin to reduce the force. I'm going to talk to the master mechanic."

Carter gave Evans very little consolation and no more money at all and that was that.

After the roundhouse force was reduced until the place looked like a government bureau office on Saturday afternoon, Evans started in to comply with the order to place as many serviceable engines in storage as possible.

The 5092 was a pretty good engine. She had just been off the drop pit a little over a month. Evans decided to place her in storage along with the 2714 that had a broken cylinder casting and the 2543 that was too small to handle the heavy trains on the Plains Division if it had been in condition to run.

Evans discovered that 5087, marked for 84, had a broken frame and would be due for a five-year test at the end of the next round trip so he stored the 5087 and ran the 5092 on 84. By the end of the month six 5000 locomotives were standing on the storage track but it is

very doubtful if any federal inspector would have classed one of the six engines as "safe and suitable for service."

One day in the latter part of May, the master mechanic was walking around the shops and went out to look at the stored engines. While there he saw Evans and called the foreman over.

"I thought I told you to store serviceable engines," the master mechanic said to Evans.

"Yes," Evans replied, "but I had to run a few trains and didn't have men enough to much more than keep the yard engines in shape."

"What are you going to do if business picks up?"

"I thought perhaps we might get a little more money for June, then I'd fix up a few extra engines."

The appropriation for June was increased a little, very little. "Maybe business won't pick up," the clerk said in an attempt to be consoling.

"It's certain not to get much worse," Evans replied, "and it's due to pick up. If it does get better soon, I'll sure be over a barrel." Evans took a fresh chew of horseshoe and went to the roundhouse.

"Say, Mr. Evans, the engineer that came in on the 5088 says the air pump is not any good," machinist Monroe said. "Do you want me to go into it? I've got to clean the air on two engines that are six-months tests," he added.

Evans hesitated a moment then said, "Maybe you'd better change the pump."

The machinist started at once taking the air pump loose. When the pump was about ready to lift off he told his helper to tell the portable crane operator.

"What do you want me to do with it?" the crane operator asked when the pump was lifted off.

"Take it to the storeroom," the machinist said, "and bring another pump back."

The crane operator hauled the defective pump to the storeroom, but he didn't bring another back for the simple reason that there wasn't any to bring.

"What do you want me to do now?" Monroe asked Evans.

"Take a pump off one of the stored engines," the foreman said, thus violating his own order not to rob any parts from stored engines.

THAT was just a beginning. The store department, evidently under orders to economize as much as possible, let the stock run down. The six stored engines became a secondary source of supply for running repair material until by the middle of the month every one of the 5000's on the storage track was minus some parts.

Business on the Plains Division didn't pick up—it jumped all in a bunch and with very little warnings.

One morning Evans came to work at seven o'clock as usual. The morning lineup showed the usual number of trains. He glanced through the mail and almost overlooked a traingram typed on a piece of yellow clip. Evans was too shocked to swear when he read the message.

Twenty trains of soldiers and equipment were to be moved over the S. P. & W., the message read. The trains were to be run two hours apart. The first train would reach Plainville about noon of the twenty-first. Evans looked at the calendar—just five days and five hours, that was what he thought until he read the next paragraph:

"The six 5000 class locomotives stored in Plainville will be placed in service and sent to Sanford to be used on these trains. These engines must reach Sanford not later than the morning of the twentieth," Evans read and felt like Joe Louis had hit him in the pit of the stomach. That meant the engines must be ready to run out of Plainville not later than ten o'clock the night of the nineteenth. Four working days to get six extra engines and not enough men to handle running repairs!

Evans, still in a daze from the traingram, went to the roundhouse to line up the work for the men to start on at eight o'clock. After the whistle blew he went to the office and told the clerk to call in every available man that had been cut off and tell them to report for work at once.

Jenson, a machinist, was the only man that could come at once. He reported for work at 8:30.

"I want you to inspect the six stored engines," Evans told the machinist, "and make a list of all material required to get them in condition to run. No," he said, "just inspect five. The 5087 is due for a five-year test. No use trying to get her ready."

Two more machinists and two machinist helpers could come in at noon. Another machinist could report next morning. Two boilermakers and one boilermaker helper and a pipefitter were all that could be located. The rest of the cut off men were either out of town or working on jobs that they wouldn't quit for four or five days work on the railroad.

When Evans saw the list of material needed for the stored engines he almost swooned. It seemed that almost everything except frames and boilers were needed to put the engines in service.

"Is this all?" Evans asked the machinist.

"That's all that has been taken off. I didn't check bushings or anything for wear but wouldn't be surprised if some of them don't need renewing."

"I'll be surprised if they don't," Evans said as he started to the storeroom. "Wish you would check over this list of material and wire for passenger shipment on all you don't have in stock," the foreman said to the storekeeper.

The storekeeper looked at the list: one air pump, two feedwater pumps, one injector complete, two lubricators, a main rod. "You want me to have this stuff all shipped passenger?" the storekeeper almost exploded.

"No, just the part that you don't have in stock."

"Why, they'll run me off the railroad for life if I wire for all of that to be shipped passenger."

"They'll run me off if you don't," Evans said, "besides tying up about nineteen out of twenty trains that are scheduled to run four days from now. After you get through checking over that list, I'd like to see how you are fixed for brass bushings. Chances are we'll need to wire for some of them to be shipped along with this other material."

Evans was correct. The stock of brass in the storeroom was based on current consumption and short for that. Almost a ton of brass would be required in addition to that on hand in the next seven days.

The storekeeper dropped in a chair completely overcome. "It's absolutely impossible! Even if I wire for all of the material it won't get here in time. Then you couldn't use it and I would have it all on hand."

"O. K.," Evans turned as if he were going to leave the storeroom, "I'll just tell the master mechanic that it's impossible for me to get locomotives ready for the extra trains because of material shortage."

"But that would place me in an awful hole," the storekeeper almost moaned. "You can't do that."

"The hole I'm in already is big enough for two of us," Evans replied.

"How am I going to explain it?" the storekeeper asked.

"Well, just wire the system storekeeper that on account of an emergency caused by these additional trains this material is required immediately and request that it be loaded in a baggage car and shipped by the first passenger train. That's our only chance."

In the meantime the hostler had shoved two of the dead engines into the house. One of them, the 5094, had been robbed of feed-water pump and lubricator besides several valves. The foreman told Jenkins to take the needed appliances off the 5087, no chance of getting her ready to run anyway.

The two machinists that came in at noon, Henderson and Thomas, had one helper between them. They went to work on the other locomotive, the 5096. Henderson was told to inspect the engine and make out a work report of repairs needed. "And don't report anything that isn't absolutely necessary unless it's a government defect," Evans added.

The three machinists worked with a will until about the middle of the afternoon when Evans came by. Henderson appeared to be stalling and Thomas wasn't in sight.

"How are you getting along?" Evans asked.

"Waiting on machine work," Henderson said.

The foreman went to the machine shop to see how things were going. The reduction in force had just left three machine men. Cox did most of the lathe work. Jenkins was on the wheel lathe and occasionally helped out on one of the small lathes, while Martin tried to keep up with work on the boring mill, shaper and planer. All three of the men were busy. Cox had his eighteen-inch lathe in high and was making brass shavings fly but at that it would take two days for him to finish all the rough brass stacked by the lathe.

"Have you started on the bushings for the 5096?" Evans asked the machine man.

"No," Cox replied, "I've still got a main brass, two middle connections, and three other bushings for running repair jobs."

Jenkins was busy turning a set of tires for an engine to run that night and Martin was boring driving boxes for the same engine.

Not one of the three men called back were good machine men. Then Evans remembered that the one reporting next morning was not a machine man either. Of course all of them had done some machine work but it had been a long time ago and none of them had been exceptionally good.

Evans went to the office. "Have you tried to see if you can locate any more machinists?" he asked the clerk. "You know there isn't a single machine man in the bunch."

"All of the good machine men have got jobs, I guess," Harris said. "The only two that I know of that were cut off went to work at a navy yard somewhere."

"That's a hell of a mess!" Evans groaned. He turned and left the office.

He went back to the machine shop and told Cox to work overtime until he had finished the bushings for the 5096 so that the men working on the engine would have them ready next morning. He then told Henderson and Thomas to start working on the 5094.

NEXT day two more of the engines were taken out of storage and shoved in the house. There wasn't any stall room for the other one.

Work progressed very nicely until noon, then almost came to a standstill for lack of material. Just before the twelve o'clock whistle blew, Evans went to the storeroom to see if there was any message about the material that had been ordered.

"Haven't heard a thing," the storekeeper said, "and if I do it may be a message telling me that I am fired."

"Well, if they'll let me go by the way, I'm eligible for my pension," Evans said. "And if that material doesn't come in on the Limited tonight I'll need it."

Evans went home for lunch more from habit than hunger. Even the strawberry shortcake, his favorite dessert, didn't taste good as usual.

At one o'clock the storekeeper still hadn't heard anything. At one-thirty the dispatcher called and wanted to know how the engines were coming along for the troop trains.

"From the way it looks now," Evans said, "they're coming like airplanes for the Allies—on the way but maybe too late."

He had just hung up the receiver when the storekeeper came in carrying a yellow slip of paper. "Your material will be here on the Limited tonight," the storekeeper said. "You can always depend on the store department."

"Yeah, you can always depend on the store department to leave you in a hole. Say, how about having the car set out by the side of the machine shop where it'll be handy," Evans added.

"Might be a good idea at that. Besides, it'll save having my men unload it," the storekeeper said.

That afternoon an engine was finished on the drop-pit and the other stored engine shoved in and men set to work taking down parts to be repaired or replaced. That done, there was little more to do but wait for the car of material and hope for the best. Evans told the night foreman to be sure and work every engine that came in during the night and have them ready to go next day even if it meant working the entire night force overtime. He also told Cox and Martin to come to work at six o'clock next morning and start making bushings.

Evans came down at six next morning too. He found the entire night force still working. Cox and Martin were there but weren't working. The baggage car with the material in it hadn't been brought to the roundhouse.

Evans called the third trick dispatcher and asked him when the car would be set.

"Don't know," the dispatcher said. "Call the yardmaster."

"We've got a lot of work in the yard," the yardmaster said, "but we should be able to get it by ten o'clock."

Evans swore and called the superintendent at his home. Thirty minutes later the switch engine came up to the roundhouse lead shoving the baggage car.

Everybody in the roundhouse except one inspector and the two laborers that clean the house went to work on the five engines when the eight o'clock whistle blew. The 5096 that had only needed a mainrod bushing was ready to run out of the house before ten o'clock.

"One out and four to go," Evans said as the hostler ran the engine across the turntable.

All of the men were working but busiest of all were Cox and Martin making bushings for the engines. The way those two nutsplitters were turning out bushings was a sight. One cut to get the size and a few licks with a file to smooth them up and the outside was finished. Two cuts on the inside and here's another bushing. Then blam! clash!—the old lathe Martin was running started to fall apart like the old one horse shay.

The machinist found the foreman and told him what had happened.

"How long will it take to repair it?" Evans asked.

"About two days if we had the parts," Martin told him.

When Jim Evans gets too worried to swear he's in a bad way and this was one of the few times he was ever in that condition. He stood for a moment as though ready to walk off and leave the whole thing. Then he shrugged his shoulders and said, "Maybe now I might get that new lathe they've been promising for the past five years."

"I can do fairly well making the large bushings on the boring mill," the machinist said, "but it'll be a little slow."

"That's right," Evans agreed. "If the old boring mill don't blow up too! Go ahead and do the best you can."

The five o'clock whistle wasn't quitting time for most of the men that afternoon but just a signal that overtime was beginning.

At six o'clock the dispatcher called and wanted to know if two of the 5000's were ready to go at eight. "Then I'll want two more at nine and two at ten-thirty," he added.

"Tell him," Evans said, "the two will be ready at eight. I hope we can have two for nine and not to figure too strong on any more."

Evans had been figuring on using the engine that came in on the Limited for one of the troop trains and it came in with a badly cracked siphon and that left him one engine short any way he figured it. (He sat down at the desk in the office and began thinking aloud.) "The engine that comes in on the first extra we can turn for the seventh train and so on, but I've got to have something to pull the first six, which I haven't." The phone interrupted his reverie.

"If it's the dispatcher, tell him I'm not here. Tell him I've joined the Foreign Legion."

The clerk answered the phone. "O. K., yes, I'll tell him," he said and hung up and turned to Evans who was braced for the bad news. "The dispatcher said that there was some delay loading the troops and equipment and the trains would be about six hours later than the lineup. He'll let you know later about the other four engines."

"I've cussed the government for being slow plenty of times," Evans said, "but this is one time I'm thankful for it. I'm going home and go to bed. . . . Good-night."

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Determining Boiler Evaporation, Size of Injector and Safety Valves

Q.—What is the proper method of figuring the amount of water used in a boiler per hour? What is the proper method to be used in determining the size of both the injectors and the overhead muffler applied on modern locomotives? I am interested in purchasing a hand book that is applicable to railroad work in connection with the figuring of locomotive problems such as, speed, boilers, coal and water consumption, etc. Can you advise me where such a book may be purchased?—F. A. J.

A.—The amount of water used in a locomotive boiler per hour is based on the evaporative values of the tubes, flues, arch tubes and firebox. The evaporative value of tubes and flues is taken at 10 lb. per hr. per sq. ft. of outside surface. The evaporative value of the arch tubes and firebox is taken at 55 lb. per hr. per sq. ft. Best available data shows that the evaporative value of tubes and flues varies with the difference in length, diameter and spacing. F. J. Cole's "Locomotive Ratios" give the evaporative values for locomotive boiler tubes and flues based on the diameter, spacing and length.

Example: Given a boiler having 248 2-in. o. d. tubes, ¾ in. spacing, 20 ft. long and 34 5⅜-in. o. d. flues, 1 in. spacing, 20 ft. long and 232.5 sq. ft of firebox and arch-tube heating surface

From Cole's Ratio we find that a 2 in. tube, 20 ft. long, has a heating surface of 10.472 sq. ft. and an evaporative value for ¾ in. spacing of 8.32 lb. per sq. ft. per hr.

The total evaporative value of the tubes would then be

$$10.472 \times 8.32 \times 248 = 21{,}607 \text{ lb. per hr.}$$

From Cole's Ratios we find that a 5⅜-in. flue, 20 ft. long, has a heating surface of 28.143 sq. ft. and an evaporative value for 1 in. spacing of 10.22 lb. per sq. ft.

The total evaporative value of the flues would then be

$$28.143 \times 10.22 \times 34 = 9{,}780 \text{ lb. per hr.}$$

The evaporative value for arch-tube and firebox surface is 55 lb. per sq. ft.

The total evaporative value of the arch tubes and firebox would be

$$232.5 \times 55 = 12{,}788 \text{ lb. per hr.}$$

The total water evaporated per hr. by the boiler would be

$$21{,}607 + 9{,}780 + 12{,}788 = 44{,}175 \text{ lb. per hr.}$$

Injector sizes are based on steam and water consumption per cylinder horsepower, for basis of calculation the steam and water consumption are taken as follows:

		Maximum steam consumption per cylinder hp.-hr.	
Cylinders	Steam	Pounds	Gallons
Simple	Saturated	27.0	3.24
	Superheated	20.8	2.50
Compound	Saturated	23.5	2.82
	Superheated	19.7	2.36

The above is based on the boiler and cylinder horsepower being equal. When the boiler horsepower is less than the cylinder horsepower, make proportional decrease or increase in capacity of injectors.

For road service the per cent of maximum steam consumption supplied by one injector is taken as 75 per cent for coal burners and 87 per cent for oil burners.

The above is based on 200 lb. pressure. For each 10 lb. pressure under 190 lb. deduct 2 per cent of the capacity as calculated.

Cylinder horsepower is obtained as follows:

Hp. $= .02120 \times P \times A$ for saturated steam
Hp. $= .02290 \times P \times A$ for superheated steam where
Hp. = cylinder horsepower
P = boiler pressure, lb. per sq. in.
A = area of one cylinder diameter.

The maximum horsepower is assumed to be reached at piston speeds of 700 ft. per minute with saturated steam and 1,000 ft. per minute with superheated steam.

Example:

Given a coal-burning road locomotive with 25 in. cylinders, superheated steam, 200 lb. pressure. Boiler and cylinder horsepower being equal. The cylinder horsepower would be

$$\text{Hp.} = .02290 \times 200 \times 490.87$$
$$\text{Hp.} = 2{,}081$$

The water consumption would be

$$2{,}081 \times 2.50 = 5{,}200 \text{ gals. per hr.}$$

(Continued on next left-hand page)


1,459,000 CHILLED WHEELS
PURCHASED in 1939... EXCEEDS
1938 BY 179,000 WHEELS
Users of these wheels will find that chilled wheels now cost less per mile than ever before, due to the continued metallurgical and design improvements which have resulted in far better performance standards—
4 Savings
With Chilled Car Wheels
1 Lowest cost per mile
2 Increased Rail Life
3 Increased Brake Shoe Life
4 Reduced Machine Shop Cost
ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS
230 PARK AVENUE,
NEW YORK, N. Y.
445 N. SACRAMENTO BLVD.,
CHICAGO, ILL.
AMCCW
ORGANIZED TO ACHIEVE:
Uniform Specifications
Uniform Inspection
Uniform Product

Requiring a capacity of 75 per cent of maximum consumption, each injector must therefore supply

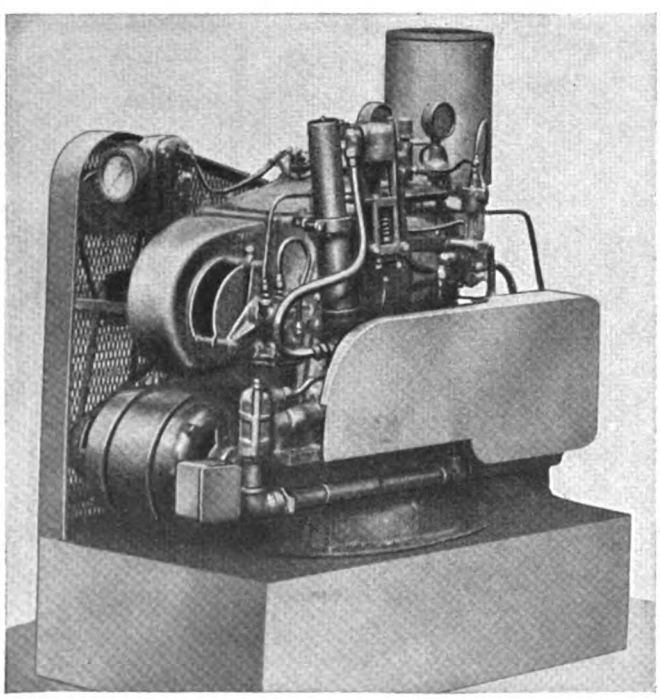
$$5{,}200 \times .75 = 3{,}900 \text{ gals. per hr.}$$

Safety Valves

The required discharge capacity of a safety valve or valves for a boiler may be based either on the heat units in the fuel consumed or on the amount of steam generated. Rules and examples are given in the A. S. M. E. Code Book. Books on locomotive boiler problems are as follows: (1) For rules and formulas covering boiler calculations; the A. S. M. E. Boiler Code, Section III, published by the American Society of Mechanical Engineers, 29 West 39th street, New Yokr City; (2) for basic design and theory of constructional details; Design of Steam Boilers and Pressure Vessels, by Haven and Sweet, published by John Wiley & Sons, Inc., New York City; (3) a practical locomotive boiler book; A Study of the Locomotive Boiler, by Lawford H. Fry, published by the Simmons-Boardman Publishing Corp., New York City; and (4) for the development of the plates of a locomotive boiler; Laying Out for Boiler Makers, published by the Simmons-Boardman Publishing Corp., New York City.

Locomotive and Car Cleaner

The No. 4941 Vapor Thermo-Pressure cleaning machine has been developed by the Vapor Car Heating Company, Chicago, especially for cleaning railroad cars and locomotives and is designed to deliver 8 gal. of water per min. at temperatures up to 165 deg. F., and at pressures up to 175 lb. It can be operated by electric or gasoline engine power and is available in either the stationary or the portable type. Some of these units have been in operation during the past year, particularly for cleaning locomotives. Diesel oil, or its equivalent, is recommended for fuel. The fuel consumption is said to be only four gal. per hour and it is used only during the actual time the cleaner is in operation. The unit will build up to full pressure and temperature within two minutes from the time it is started.



Vapor No. 4941 Thermo-Pressure machine for cleaning locomotive and car equipment

In addition to the small water tank, a separate "solution" tank is installed for use as desired. When cleaning locomotives, a special gas oil or "U. G. I. Cleaning Oil" is automatically added to the water, which leaves a thin film to protect metal parts against rusting.

Special pump and by-pass features are incorporated to meter the oil or other cleaning solution into the water as desired. All necessary control and safety features are installed. When the hand valve on the cleaning nozzle is closed, the fire will shut down, and automatically come on again when the nozzle valve is opened. In case of failure of water supply, the burner will shut down. The unit is constructed on the Clarkson staggered-coil principle.

One of the important economies which must be credited to the Vapor Thermo-Pressure cleaner is avoidance of the necessity of carrying locomotive steam pressure on main boiler plants during summer months for washing locomotives, car trucks, and freight or passenger cars.

Paducah Shop Jigs, Fixtures and Devices

(*Continued from page 327*)

brass rigidly in the fixture during the machining operation.

Crown brasses, placed and held in the arrangement, can be machined accurately and quickly and in addition there is a saving of time in the setting up operation.

Moving A Pair of Driving Wheels

Necessarily numerous locomotive parts are moved from place to place at any locomotive repair shop and these moving operations become greater in proportion to the size of the shop and volume of the work.

At Paducah shop, the method of moving mounted driving wheels is shown in one of the illustrations. A five-ton lift truck is used with the blocking carefully placed clear of the journals. Before adopting this method of moving them the rolling and handling of driving wheels was slow and expensive.

Opening A Shop Door

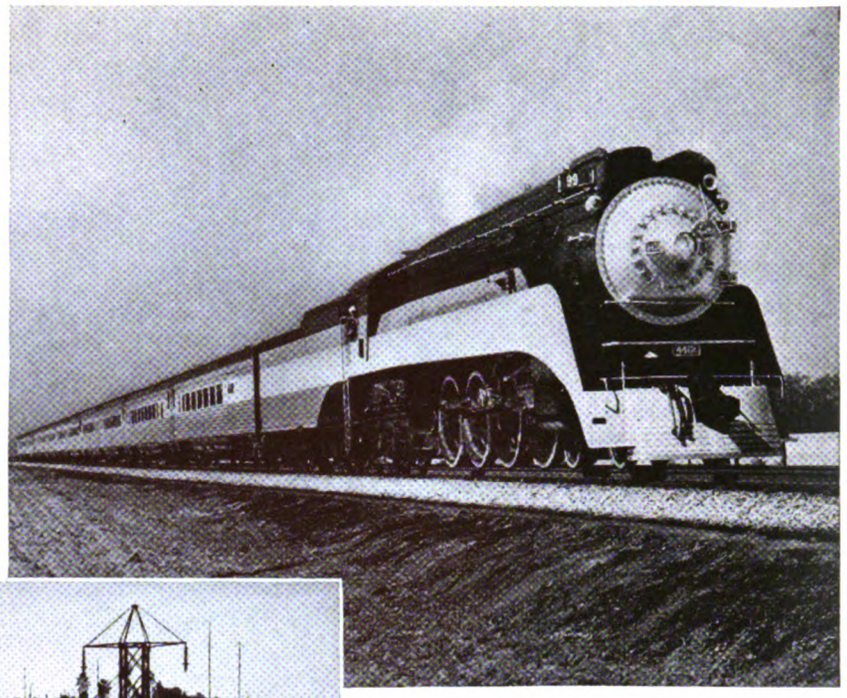
An air-operated shop door opener and closer is used for passing lift trucks, crane trucks and other pieces of like equipment through the shop door. Operating equipment inside the shop consists of a 3-in. cylinder of a length to accommodate the door opening. A ¾-in. piston rod is used with leather-packed piston and a cushion in each end of the cylinder with springs to check the travel of the door as it opens or closes.

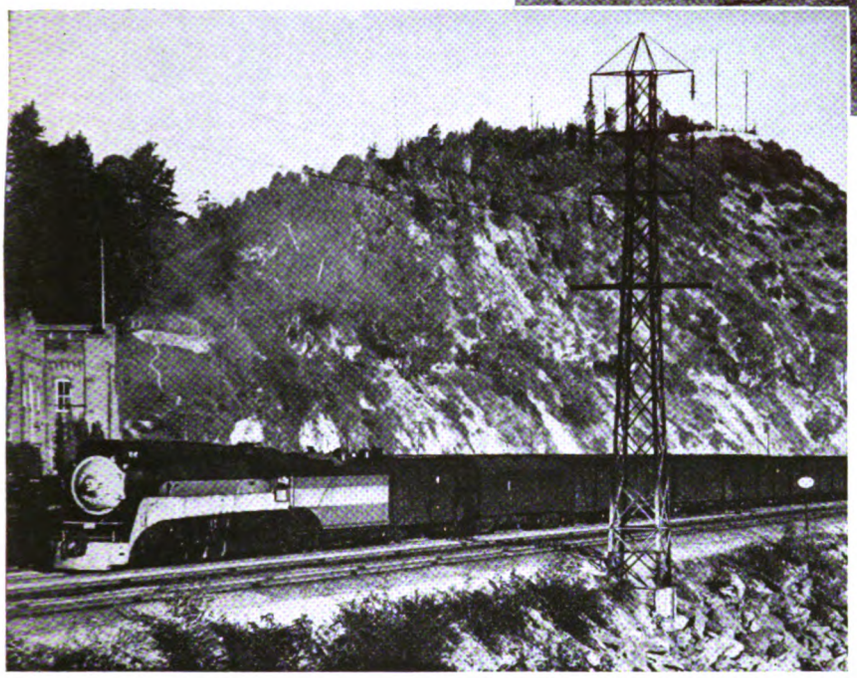
Shop air pressure is used, but through a reducing valve set at just sufficient pressure to operate the door. A three-way valve is installed and operated by a tiller rod with rope control which extends out 12 ft. on either side of the door in easy reach of truck operators who can open the door, pass through it and close it from the inside without getting off the truck.

Another advantage to this arrangement is that when the trucks pass in or out of the door, it remains open a minimum of time and saves admitting a large amount of cold air into the building. The door opener, of course, is used only during the winter months.

(*Turn to next left-hand page*)

FAMOUS TO PASSENGERS AS *Daylights*





FAMOUS TO SHIPPERS AS *"Overnights"*

To meet the requirements of shippers for "speed" some of the more progressive railroads are now using the same locomotives for both heavy duty passenger and high speed freight service.

This trend is becoming increasingly popular with shippers as a time saver and with the railroads as a revenue producer. *Photo courtesy Southern Pacific Company.*

LIMA LOCOMOTIVE WORKS LIMA LOCOMOTIVE WORKS INCORPORATED **INCORPORATED, LIMA, OHIO**

High Spots in
Railway Affairs . . .

Railroads and National Defense

Transportation is naturally one of the most vital links in the national defense program, as well as in actual warfare. The railroads must be depended upon to function as its backbone, since they will handle the long and bulky, or mass production movements. Their activities, however, must be closely co-ordinated with other types of transportation in order to secure the most efficient and effective service in the movement of men and materials. Lessons learned from experiences in the first World War and in the reconstruction period resulted in the preparation of carefully made plans to meet future contingencies. The railroads, therefore, now find themselves in far better position to face the demands that may be made upon them than when a similar situation confronted them a quarter of a century ago.

Ralph Budd's Progress Report

Ralph Budd, president of the Burlington, and one of the six members of the National Defense Advisory Commission, heads up its Division of Transportation. In reporting to President Roosevelt on July 16, he pointed out that his division was working closely with the A. A. R. and the American Short Line Railroad Association. He emphasized "the need for full performance by all lines of the repair work necessary to reduce cars in bad order to not more than six per cent," as was agreed upon by these associations. Special rolling stock will be required for handling troops and their equipment. President Roosevelt has indicated that this should be paid for by the government, since it will not be of use for civilian transportation movements. Special flat cars will be needed, for instance, for the loading of tanks within the clearance limits. These matters are receiving special attention by Mr. Budd and his staff.

Mr. Budd's Advisors

One of the first acts of Mr. Budd was to appoint to his staff the following four consultants: A. T. Wood, president, Lake Carriers Association, Cleveland, Ohio; Ted V. Rodgers, president, American Trucking Associations, Inc., Washington, D. C.; F. C. Horner, New York, assistant to the chairman, General Motors Corporation; and Arthur M. Hill, president, National Association of Motor Bus Operators. About the middle of July the following additional four men were appointed advisors: J. M. Hood, president of the American Short Line Railroad Association; Thomas P. Henry, president of the American Automobile Association; Fayette B. Dow, Washington representative of the American Petroleum Institute; and A. W. Dann, of the Union Barge Line Corporation, Pittsburgh, Pa.

Rail-Labor National Defense Committees

Transportation associations have been prompt to indicate a willingness to aid in the national defense program. This has been true, also, of the labor organizations. Committees to co-operate in the disposition of problems of mutual interest which may arise from this program have been appointed by the A. A. R. and the Railway Labor Executives' Association. It is understood that the functions of these special committees will not supersede or replace in any way the regular machinery for dealing with hours, wages and working conditions; their work will be confined to matters arising under the defense program.

C. S. D. Creates Military Transportation Section

A Military Transportation Section has been created by the Car Service Division, A. A. R., with Arthur H. Gass as manager, effective August 1, to maintain close liaison between military forces and the railroads.

Freight Car Requirements

The railroads face the necessity of acquiring a half million new freight cars before the end of 1942. This is the tentative conclusion of R. N. Janeway in a report prepared for the National Resources Planning Board. It has not yet been presented to the board, but has been distributed in a limited way for confidential review and criticism. The estimate is based on a study of the correlation between carloadings and the Federal Reserve Board index of industrial production, and assuming maximum potential production with full employment. The study indicates that by the end of 1942, about 360,000 more cars will be required than are now available. Meanwhile, however, 140,000 cars will become due for retirement, so that in all 500,000 new cars will be retired.

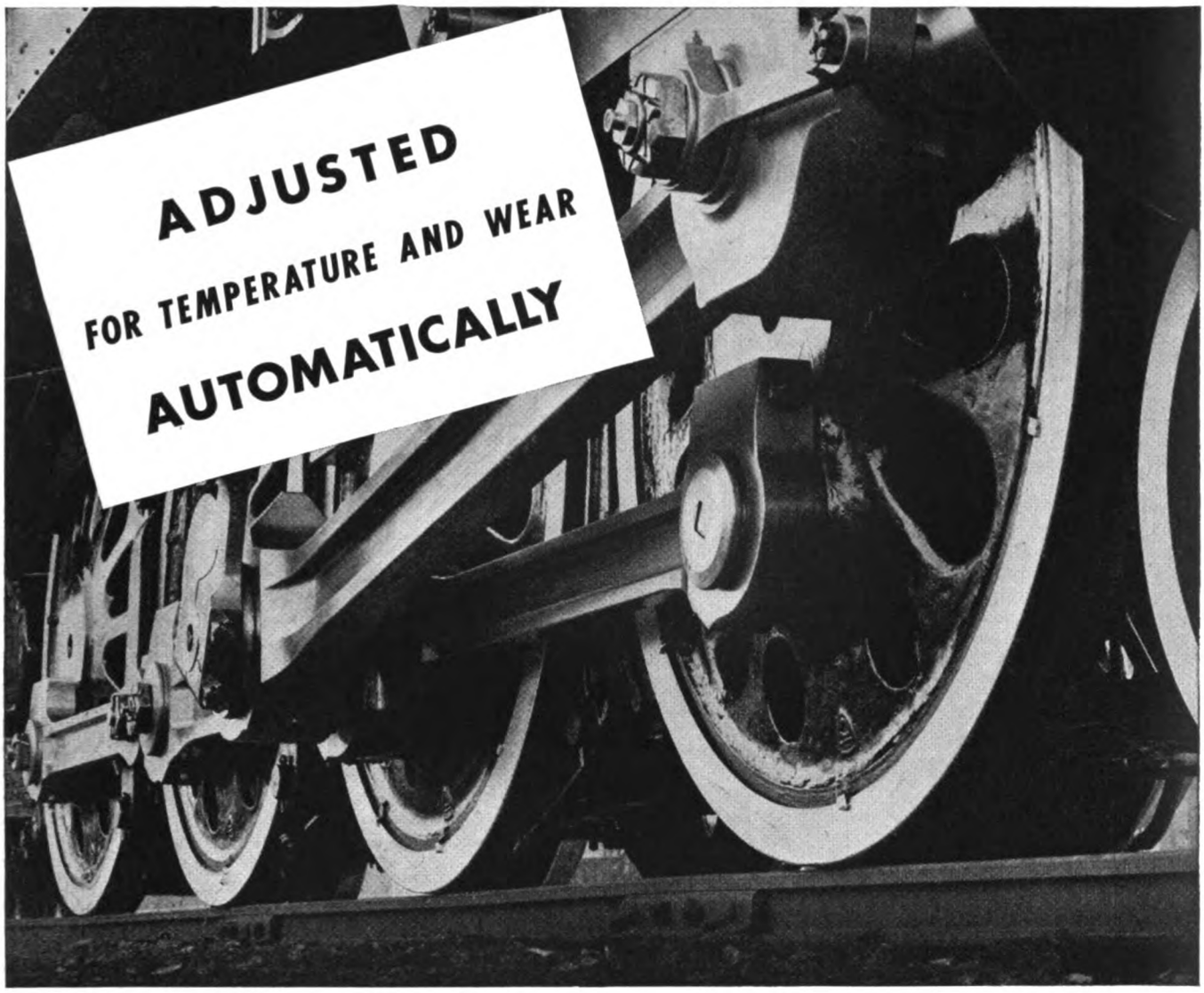
Mr. Gormley's Estimates

M. J. Gormley, executive assistant of the A. A. R., certainly knows railroading. Moreover, no railroad officer has had so close a contact with the War Department and its needs. In speaking before the Northwest Shippers' Advisory Board on July 25, Mr. Gormley said, "One of our difficulties now is the hysteria on the part of some people as to the magnitude of the transportation load in connection with the preparedness program." He suggested that the public should not be influenced by "the conclusions of the astronomical statisticians" and also said that "protection from well meaning, but unknowing friends is one of the greatest needs of the railroads." Mr. Gormley based his statements upon the estimate that "the increased annual steel output, maintenance of three million troops and material for camp construction would involve an average rail movement of about 25,396 carloads per week, or about four per cent of the average weekly carloadings in 1939." Double this to be safe and it "offers no very great problem to the railroads." He also pointed out that the freight car supply will be much larger this year than a year ago.

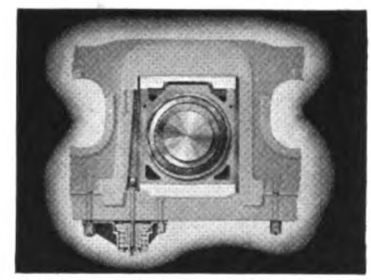
R. B. A. Goes On Record

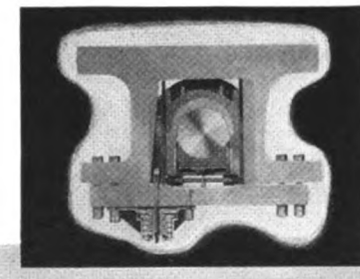
The Railway Business Association has published a study, entitled Transportation and National Defense. It shows that the burden of such transportation will fall almost entirely upon the railroads and concludes: "But should national defense require the mobilization of forces in large numbers (to implement the preparedness program in actual defense of the nation) there is ground for apprehension that the total traffic thus resulting would be greater than the capacity of the supply of locomotives and cars contemplated by the Association of American Railroads—or that could be made available from the small unserviceable inventories that remain." It suggests that the federal agencies responsible for formulating and executing the national defense program should take this into consideration and make provision for the contingency. "Such provision of rail equipment is as much a part of the cost of war and preparation for war," says the report, "as emergency building of shipping in 1918 or the expansion of airplane factories in 1940, or the sinking of government moneys in highways and waterways for the alleged purpose of promoting the national defense."

(Turn to next left-hand page)



Variations in the driving box temperature, which in some instances are as much as 250° in short periods of time, no longer affect the fit of these driving box wedges. This ever-present problem has been effectively solved by the application of Franklin Automatic Compensators and Snubbers. Now, this locomotive leaves the roundhouse with a snug fit; as the driving box becomes heated the wedge is *automatically* pushed down, keeping a constant, pre-determined adjustment at all times. As the driving box cools, the wedge *automatically* compensates for the contraction. In addition, abnormal shocks are taken care of by a heavy outer spring that acts as a cushion. » » » For constant, accurate adjustment . . . easier riding, prevention of pounds . . . *at any temperature* . . . apply Franklin Automatic Compensators and Snubbers.





ABOVE: Franklin Automatic Compensator and Snubber for Roller Bearing Driving Box application. BELOW: Franklin Automatic Compensator and Snubber for Friction Bearing Driving Box application.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

NEWS

"400's" Locomotives Complete 300,000 Continuous Service Miles

Two 4,000-hp. Diesel-electric locomotives which the Chicago & North Western uses to haul its "400" and its North Western Limited between Chicago and the Twin Cities, completed 300,000 miles each in continuous service on July 13. The locomotives were delivered to the railroad in May and June, 1939, and after test runs, were used on the North Western Limited in July, August and September. With the placing in service of the new "400" on September 24, 1939, they were also assigned to the "400" on a schedule which provides for morning arrival at each terminal with the North Western Limited and afternoon departure with the "400." As a result, each of these locomotives has traveled 861 miles per day since September 24, 1939, and has been on the road 16 hr. 35 min. in each 24 hours.

Equipment Purchasing and Modernization Programs

Chesapeake & Ohio.—On July 15, the Chesapeake & Ohio awarded an issue of $2,500,000 of one- to ten-year 1¾ per cent equipment trust certificates to Blyth & Company, Inc., at a price of 101.777, which represents an interest cost to the company of about 1.41 per cent. The certificates, dated August 1, 1940, will be payable in 10 equal annual installments. The funds will be used to finance in part the purchase of new equipment, including 1,000 box cars and 100 cabooses. Blyth & Co. have offered the issue of $2,500,000 certificates at prices to yield from 0.25 per cent for 1941 maturities to 1.75 for certificates maturing in 1950.

The C. & O. is also contemplating the repair of its coach shop building at Richmond, Va., replacing wood floors with concrete, providing additional pit tracks and overhead cranes, and replacing swinging doors with overhead doors; and erecting a new paint spraying building with canopy exhaust system, lean-to and toolroom at Huntington, W. Va., all of the above work to cost approximately $99,000. Plans are being prepared to ask for bids on the overhead doors at Richmond and all of the work at Huntington, the balance of this work to be done by company forces.

Illinois Central.—The Illinois Central awarded a contract to the Knickerbocker Roofing & Paving Co., Chicago, for repairs and recoating of the roofing on all shop buildings at the Paducah shops, Paducah, Ky. Another contract has been awarded to the H. J. Yeldham Company, Chicago, for making repairs to monitor sash, gutters, downspouts, flashing and other sheet metal work on the roofs of these buildings. The total cost of this work will be about $50,000.

Norfolk Southern.—Division 4 of the Interstate Commerce Commission has approved a plan whereby the Norfolk Southern would issue and sell to the Reconstruction Finance Corporation $136,000 of 2½ per cent equipment trust certificates maturing in semi-annual installments of $7,000 from February 1, 1941, to August 1, 1948, inclusive, and of $6,000 from February 1, 1949, to August 1, 1950, inclusive.

Pennsylvania.—The Pennsylvania has asked the Interstate Commerce Commission for authority to assume liability for $7,995,000 of 2¼ per cent equipment trust certificates, maturing in annual installments of $533,000 on July 1, of each year from July 1, 1941, to and including July 1, 1955. The proceeds will represent 80 per cent of the total purchase price of equipment costing $9,993,750, and consisting of 2,545 freight cars, 25 steam locomotive tenders, two steam passenger locomotives and tenders, and eight lightweight passenger cars. The petition states that the Pennsylvania will construct the freight cars and tenders in its own shops.

New Freight Cars Put in Service in First Half Year Total 36,852

CLASS I railroads put 36,852 new freight cars in service in the first six months of 1940, according to the Association of American Railroads. This was the largest number installed in any corresponding period since 1930 when 49,208 new cars were put in service. In the first half of 1939, there were 8,628 new freight cars installed.

Of the total number of new freight cars placed in operation in the six months' period this year, coal cars numbered 19,076; box, 16,007; refrigerator, 595; flat, 569; stock, 88, and miscellaneous, 517.

At the same time, the railroads installed in service 180 new locomotives, of which 45 were steam and 135 were electric and Diesel-electric. Installed in the first six months in 1939 were 126 new locomotives, of which 16 were steam and 110 were electric and Diesel-electric.

Class I railroads on July 1 had 16,933 new freight cars on order, compared with 10,062 on the same day last year. On June 1, there were 15,039 new freight cars on order. Among the new cars on order on July 1 were 9,286 box; 7,005 coal; 245 flat; 50 refrigerator, and 347 miscellaneous. The railroads on July 1 also had 124 new locomotives on order, of which 97 were steam and 27 were electric and Diesel-electric. On the same day one year ago, there were 108 on order, of which 60 were steam and 48 were electric and Diesel-electric.

Freight cars and locomotives leased or otherwise acquired are not included in the above figures.

Average Age of Railroad Workers 43 in 1938

"JUST under 43" was the average age of all workers covered by the Railroad Retirement Act in 1938, according to age data summarized in an article appearing in the latest issue of the Railroad Retirement Board's Monthly Review. The data on ages by occupations show that engineers and conductors are the oldest group with an average age of 55.1 years, and extra gang men the youngest group with an average age of 32.7 years.

Occupations of annuitants are shown in another study. The largest proportion of annuitants of Class I roads comes from the skilled maintenance of equipment group which makes up 16.8 per cent of the total and the senior train and engine service groups which account for 16.6 per cent.

Department of Justice Sues Pullman

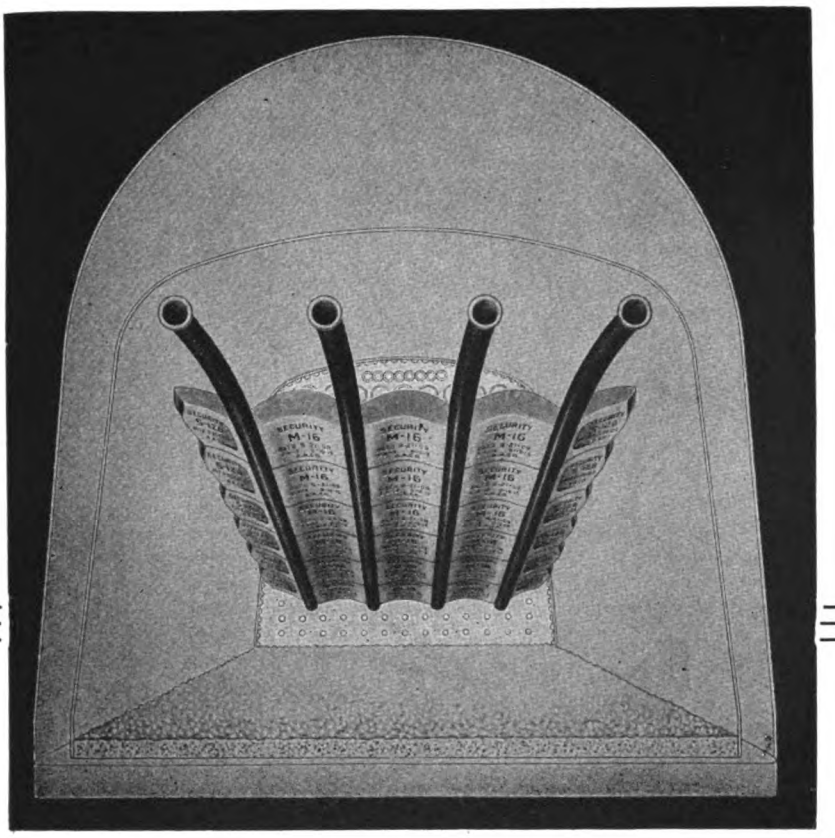
THE Department of Justice on July 12 filed in the Federal District Court at Philadelphia, Pa., a complaint under the federal anti-trust laws against the Pullman Company and its affiliates and officers. "Briefly stated," said Assistant Attorney General Thurman Arnold in announcing the suit, "the substance of the complaint is that the Pullman organization has prevented the railroads from using modern, lightweight, streamlined cars manufactured by competing companies in order to maintain in service its own obsolete equipment. It is charged in effect that the dominant position of the Pullman organization has given it power to force on the railroads restrictive contracts which compel them to use Pullman-built-and-operated sleeping-car equipment exclusively, or it cannot be used at all. It is alleged that the railroads and the traveling public have been denied the widespread use of modern equipment by the monopolistic practices of the Pullman organization."

Later on the Arnold statement explains that the action is a civil suit. Such procedure was decided upon instead of a criminal action because the contracts between Pullman and the railroads "have been publicly recorded for many years with the Interstate Commerce Commission."

"A civil proceeding is also necessary," continues the complaint, "because of the nature of the relief required. The Department believes that certain provisions of the operating contracts between The Pullman Company and the railroads should be cancelled and that the corporation which manufactures rolling stock should be divorced from the corporation which operates sleeping-car service. This relief can only be gained through civil proceedings."

Dissolution of the holding company-Pullman, Inc., as the means of divorcement

(*Continued on next left-hand page*)



ANYTHING

less than a complete arch

IS FALSE ECONOMY

To let the desire for reduced inventory result in a locomotive leaving any roundhouse without a full set of Arch Brick is poor economy. » » » Even a single missing Arch Brick will soon waste many times its cost in fuel and in locomotive efficiency. » » » To spend the fuel dollar efficiently, every locomotive Arch must be maintained 100%. » » » Be sure your stocks on hand are ample to provide fully for all locomotive requirements, so that locomotive efficiency may be maintained.

There's More to SECURITY ARCHES Than Just Brick

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



AMERICAN ARCH CO.
INCORPORATED
60 EAST 42nd STREET, NEW YORK, N. Y.

Locomotive Combustion Specialists

of the two corporations is contemplated in the action.

The complaint names as defendants four corporations and 31 individuals. The corporate defendants are: The Pullman Company; Pullman-Standard Car Manufacturing Company; Pullman Incorporated; and Pullman Car & Manufacturing Corporation of Alabama. The individual defendants are officers or directors of these companies.

I. C. C. Authorizes Experimental Cars

THE American Car & Foundry Company has been authorized by the Interstate Commerce Commission in a report by Commissioner Johnson to construct 10 fusion-welded tank cars for experimental service in the transportation of petroleum products.

The General American Transportation Corporation has been authorized in the same manner to construct one fusion-welded tank car for experimental service in the transportation of caustic soda solution.

I. C. C. Modifies Locomotive Inspection Rule 116(b)

RULE 116(b) of the Rules and Instructions for the Inspection and Testing of Steam Locomotives and Tenders and their Appurtenances has been amended by the Interstate Commerce Commission to read as follows:

(b) The front cab doors or windows of road locomotives used in regions where snowstorms are generally encountered shall be provided with what is known as a "clear vision" window, or an appliance that will clean the outside of such doors or windows over sufficient area to provide a clear view of track and signals ahead. If a "clear vision" window is used it shall be not less than 5 inches high located as nearly as possible in line of the engineman's vision and so constructed and fitted that it may be easily opened, closed and fastened in desired position.

The amendment was made in an order by Commissioner Patterson which set forth, as noted in the May issue of the *Railway Mechanical Engineer,* that the railroads had been cited to show cause by July 1 why the amendment should not be ordered. One of the "whereases" in Commissioner Patterson's order stated that "no cause has been shown by any said common carrier or party, within the time specified by the order." Language in the foregoing, not found in the present rule, includes the reference to "an appliance that will clean the outside of such doors or windows . . ."

Eastern Car Foreman's Outing

NEW HAVEN DAY, the annual outing of the Eastern Car Foreman's Association, was held at the Race Brook Country Club, New Haven, Conn., July 11 with an attendance of approximately 200 members and guests. The prize winners in the principal events were as follows: In the golf tournament Harry Nunn, Boston & Albany, took the high prize for low gross. In Class A T. M. Ferguson, American Arch Co., the low gross for the Class A golfers and Charles Stone, Railway Sales Co., was the low net winner in the same class. In Class B J. W. Cook, General Steel Castings Corporation, won low gross prize and D. C. Wilson, Thos. A. Edison, Inc., took the prize for low net score. The Class C winners were George Clarke and H. P. Hass, New Haven Road, and H. G. Davis, Railway Sales Co., took the kickers' prize. H. W. Quinlan, New Haven Road, and J. S. Doyle, Johns-Manville Company, were the putting winners. There were 26 other prizes distributed by drawing at the dinner.

George M. Verity Honored

WHILE 20,000 of his employees and townsmen at Middletown, Ohio, looked on, George M. Verity, chairman of the American Rolling Mill Company, on July 4 was given the title of America's outstanding "Humanizer of Business" by B. C. Forbes, business columnist and publisher of Forbes Magazine. A twilight parade of 3,500 marchers preceded the ceremony — composed of Legionnaires, national guardsmen, armored cavalry units, naturalized citizens, industrial workers, and other organizations.

"Not one hour of work has ever been lost during The American Rolling Mill Company's 40 years' existence through labor strife," said Mr. Forbes in bestowing the award. "So fully have employees been taken into consultation and confidence all through the years, that when outside influences from time to time sought to intrude, the men overwhelmingly turned thumbs-down.

"From his earliest small-scale beginnings to and through years of spectacular growth and success, Mr. Verity has questioned no applicant for work as to his affiliations, religious, political or with organized groups. His humane policies enabled him to get along harmoniously with all honest-intentioned men. Long, long before the government took up 'social-security,' this employer's work folks enjoyed it in generous measure. They enjoyed—and still enjoy—far greater benefits, privileges, consideration, than anything written into law even today."

The Committee of Award included: Dr. Carl W. Ackerman, Evans Clark, Dr. Kenneth Dameron, Benjamin A. Javits, General Hugh S. Johnson, Dr. Virgil Jordan, H. J. Kenner, Dr. Julius Klein, J. T. Madden, Dr. Oscar S. Pulman, Ogden Reid, Dr. Christian F. Reisner, Dr. Alexander G. Ruthven, Philip C. Staples, Dr. Rufus B. von Kleinsmid, E. R. Weidlein, Whiting Williams, and Dr. Stephen S. Wise.

Orders and Inquiries for New Equipment Placed Since the Closing of the July Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Locos.	Builder
Alaska	1	4-6-2	Baldwin Loco. Wks.
Atchison, Topeka & Santa Fe	10	4-8-4	Baldwin Loco. Wks.
Baltimore & Ohio	9	1,000-hp. Diesel-elec.	Electro-Motive Corp.
	16	600-hp. Diesel-elec.	Electro-Motive Corp.
C. R. I. & P.	1[1]	2,000-hp. Diesel-elec.	Electro-Motive Corp.
Illinois Central	1	2,000-hp. Diesel-elec.	Electro-Motive Corp.
Reading	3[2]	660-hp. Diesel-elec.	Baldwin Loco. Wks.
	2	1,000-hp. Diesel-elec.	Baldwin Loco. Wks.
	4	600-hp. Diesel-elec.	Electro-Motive Corp.
	1	1,000-hp. Diesel-elec.	Electro-Motive Corp.
	3	600-hp. Diesel-elec.	American Loco. Co.
Sao Paulo-Parana Railroad of Brazil	1	2-8-2	Baldwin Loco. Wks.

LOCOMOTIVE INQUIRIES

Reading	10	Diesel-elec.	.....
Union Pacific	16	4-6-6-4	.....

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
American Refrigerator Transit Co.	100	Refrigerator	Company shops
Illinois Central	1,000	40-ton box	Pullman-Std. Car Mfg. Co.
	1,000	50-ton box	Gen. Amer. Transp. Corp.
	500	40-ton box	American Car & Fdry. Co.
	500	Automobile	Mt. Vernon Car Mfg. Co.
Louisville & Nashville	25	70-ton hopper	Pullman-Std. Car Mfg. Co.
Newburgh & South Shore	60	75-ton ore	Pullman-Std. Car Mfg. Co.
Norfolk & Western	50	50-ton box	Greenville Steel Car Co.
	500	Hopper	Virginia Bridge Co.
	500	Hopper	Bethlehem Steel Co.
Virginian	500	50-ton hopper	Company shops

FREIGHT-CAR INQUIRIES

Atlantic Coast Line	600	50-ton box	.....
	100	50-ton automobile	.....
	100	70-ton phosphate	.....
	50	40-ton stock	.....
	15	70-ton hopper	.....
	300	55-ton hopper	.....
	300	50-ton ballast	.....
	200	50-70-ton gondola	.....
Union Pacific	1,000	50-ton ballast	.....

PASSENGER-CAR ORDERS

Road	No. of Cars	Type of Car	Builder
Chicago, Rock Island & Pacific	2[1]	Baggage-express	Pullman-Std. Car Mfg. Co.
	1	Chair	
	1	Pullman	
	1	Dining-observation-lounge	
Illinois Central	1	Observation-lounge	Pullman-Std. Car Mfg. Co.
	1	Diner	
	4	Coaches	
	1	Combination coach	

[1] This equipment is for use in the Rock Island's new St. Louis, Mo.-Twin Cities service next fall.
[2] The aggregate cost of the 13 units, which are to be used in the Philadelphia Terminal area, is estimated at $855,000.

Multi-Vent Research Laboratory

THE Pyle-National Company has completed a Multi-Vent research laboratory within a railroad coach at the company's plant in Chicago. This coach laboratory was designed for the testing of various types of Multi-Vent panels, lighting fixtures, etc., which will be changed as further progress is made in the study of air distribution.

The laboratory equipment at present consists of Pitot tubes, micromanometers to measure air pressure, laboratory thermometers, velometers and Kata-Thermometers for the measurement of extremely low air velocities, variable speed blowers and heat controls.

A complete analysis of heating or cooling problems for any type of passenger car may be made, as well as a visual study of the resultant air flow and distribution by means of smoke injected into the air stream.

Supply Trade Notes

B. S. WOODMAN has been appointed special representative of the Roller-Smith Company, with headquarters at Bethlehem, Pa.

◆

GEORGE D. CASGRAIN, vice-president of the Griffin Wheel Company, has resigned to become vice-president of the Marquette Railway Supply Company, Chicago.

◆

J. EUGENE JACKSON has been appointed metallurgical engineer of the Copper Iron and Steel Development Association, with headquarters in Cleveland, Ohio.

◆

FRANK PARKER, president of Iron & Steel Products, Inc., Chicago, has been appointed to the Railroad Scrap committee of the Institute of Scrap Iron & Steel. Mr. Parker is known for his collaboration with the Association of American Railroads and the metal industries in connection with scrap standardization.

◆

REPUBLIC STEEL CORP.—*Mowry E. Goetz* has been appointed district manager at Chicago for the Republic Steel Corporation, Cleveland, Ohio, succeeding *J. L. Hyland*, who has been appointed district manager at Cleveland, and *F. R. Ward* has been appointed assistant district manager at Chicago.

◆

GENERAL STEEL CASTINGS CORP.—*James C. Travilla, Jr.*, has been appointed chief mechanical engineer, General Steel Castings Corporation, with headquarters at Eddystone, Pa., and *E. S. Beckette* and *W. C. Krautheim* have been appointed assistant mechanical engineers of the corporation, at Granite City, Ill.

◆

WATSON WILLIAMS has been appointed district superintendent, mechanical department, Southeastern district, of the Oxweld Railroad Service Company, with headquarters at Macon, Ga., to succeed C. S. Wright, deceased. Mr. Williams was born in Milltown, Ga., and began his railroad career with the Central of Georgia at Columbus, Ga., as boiler maker. He has been with Oxweld since August, 1917, and has served as mechanical instructor assigned to many large railroads in various parts of the country.

◆

AIR REDUCTION COMPANY.—*Howard R. Salisbury*, assistant manager of the Air Reduction Company at Philadelphia, Pa., has been appointed manager, succeeding *William W. Barnes*, who has retired after 30 years' active service with the industry, and *H. B. Seydel*, assistant sales manager of the New York district, has been appointed assistant manager at Philadelphia. Mr. Salisbury has been connected with Airco for 15 years. He was manager at Bettendorf, Iowa, for two years and has been assistant manager at Philadelphia for the past six years.

Mr. Barnes first became associated with the oxyacetylene industry in 1910 when he joined the Davis-Bournonville Company as Philadelphia sales manager. In 1922, when Davis-Bournonville merged with Air Reduction, Mr. Barnes became Air Reduction manager at Philadelphia, a position he held until his retirement.

Personal Mention

General

JAMES E. HALL has been appointed traveling engineer of the Union Railroad Company, with headquarters at Bessemer, Pa.

E. J. MCSWEENEY, superintendent of motive power of the Western lines of the Baltimore & Ohio, with headquarters at Cincinnati, Ohio, has been transferred to the Eastern lines, with headquarters at Baltimore, Md.

C. P. BROOKS, supervisor of apprentices of the Erie, has been appointed mechanical engineer, with headquarters as before at Cleveland, Ohio, succeeding F. S. Brown, who is retiring after 48 years of continuous service.

Master Mechanics and Road Foremen

L. JONES, general foreman at Centralia, Ill., of the Illinois Central, has been promoted to master mechanic at Champaign, Ill., succeeding A. G. Kann.

NORMAN BELL, general master mechanic of the Iowa and Springfield divisions of the Illinois Central, retired on July 16, after more than 36 years' service.

A. G. KANN, master mechanic of the Illinois division of the Illinois Central, with headquarters at Champaign, Ill., has been promoted to general master mechanic of the Iowa and Springfield divisions, with headquarters at Waterloo, Iowa.

F. O. WRIGHT, general foreman of the Chesapeake & Ohio, has been appointed master mechanic, Hocking division, with headquarters at Columbus, Ohio, succeeding J. E. Davis, retired.

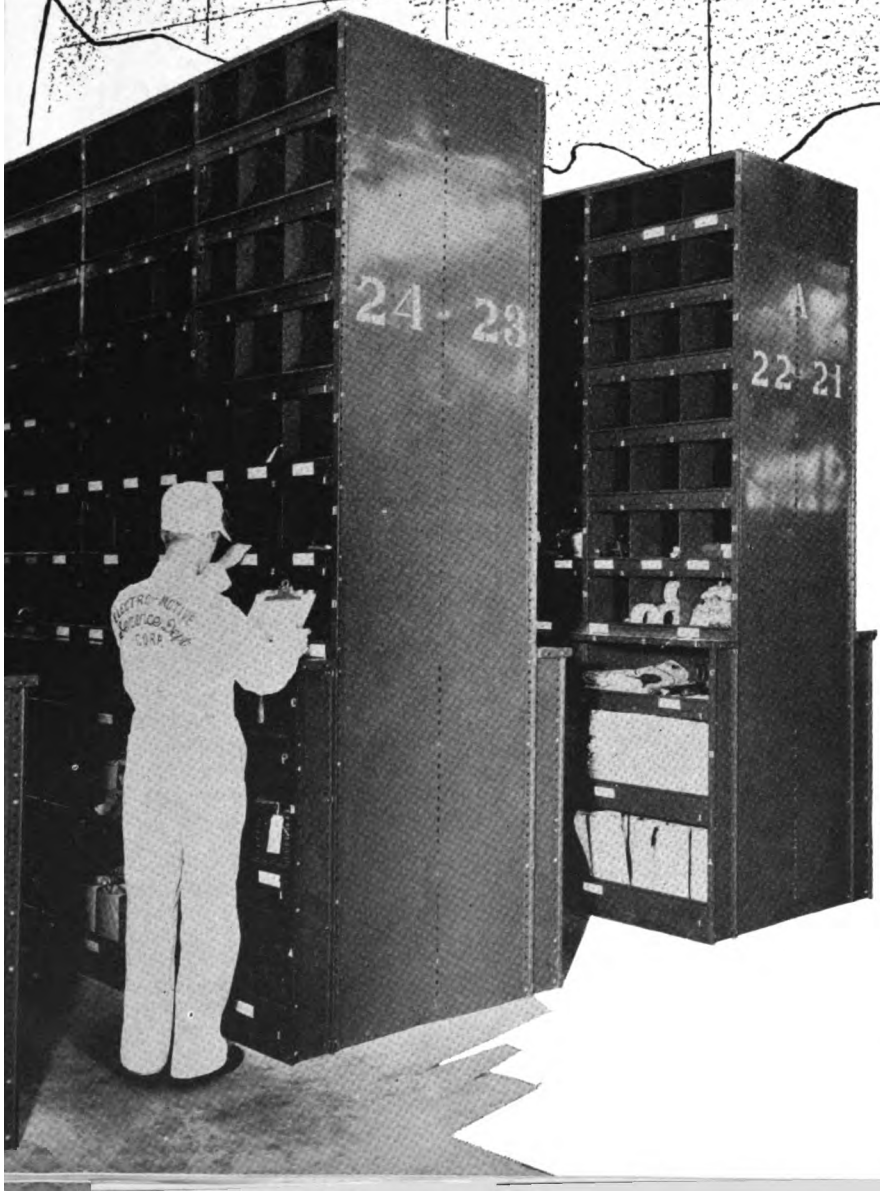
R. C. GOEBEL, assistant to the superintendent of motive power of the Minneapolis & St. Louis, has been appointed general master mechanic, a newly created position, with headquarters as before at Minneapolis, Minn.

Car Department

L. R. SCHUSTER, chief car draftsman of the Southern Pacific at San Francisco, Cal., has been promoted to engineer of car construction with the same headquarters.

(Turn to second left-hand page)

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SUBSIDIARY OF GENERAL MOTORS — LA GRANGE, ILLINOIS, U. S. A.

Purchasing and Stores

L. S. MYERS, division storekeeper on the Northern Pacific at Seattle, Wash., has been promoted to assistant general storekeeper, with headquarters at South Tacoma, Wash., succeeding Frank C. Turner.

FRANK C. TURNER, assistant general storekeeper on the Northern Pacific at South Tacoma, Wash., has been appointed general storekeeper, with headquarters at St. Paul, Minn., succeeding H. M. Smith, retired.

Obituary

WILLIAM L. TROUT, superintendent of motive power of the Minneapolis & St. Louis, with headquarters at Minneapolis, Minn., died in that city of a heart attack after a short illness, on July 21. Mr. Trout was born at Altoona, Pa., and entered railway service with the Pennsylvania on January 3, 1895, serving as an apprentice, machinist and enginehouse foreman at various points until October 31, 1913. At that time he left the Pennsylvania to go



William L. Trout

with the Western Maryland as general foreman in the mechanical department at Cumberland, Md., holding this position until February 28, 1915. On that date he went with the Baltimore & Ohio, where he served as general foreman in the locomotive department and acting master mechanic at Philadelphia, Pa. On January 1, 1916, he entered the service of the Long Island (part of the Pennsylvania) as general foreman in the car department at Jamaica, N. Y. From September 1, 1918, to June 31, 1924, he served with the Galena Signal Oil Company as mechanical expert at Chicago. At the end of this period he entered the service of the Uintah Railway as superintendent of motive power at Atchee, Colo., holding this position until June 31, 1925, when he resigned to become a special representative in the railway department of the Hulson Grate Company. From September 1, 1926, to December 31, 1932, he was a sales representative for the Gustin-Bacon Manufacturing Co. On February 1, 1935, he entered the service of the Minneapolis & St. Louis as a motive power inspector, being promoted to general master mechanic on March 1, 1935. In August, 1937, he was advanced to superintendent of motive power, with headquarters at Minneapolis, the position he held at the time of his death.

GEORGE ROBERT GALLOWAY, superintendent of motive power, Western lines, of the Baltimore & Ohio, with headquarters at Cincinnati, Ohio, died at the Samaritan Hospital, Cincinnati, on July 20. Mr. Galloway was born at St. Thomas, Ont., on July 5, 1889, and entered railroad service in October, 1905, with the Michigan Central, as a shop apprentice at St. Thomas. On April 1, 1916, he went with the B. & O. as assistant master mechanic at Glenwood, Pa., later serving as master mechanic at Lorain, Ohio; general master mechanic, Southwestern district at Cincinnati; district master mechanic at Cincinnati; and district master mechanic, Maryland district, at Baltimore, Md. On February 1, 1931, he was promoted to superintendent of motive power, Western lines, with headquarters at Cincinnati and on December 1, 1936, he was appointed superintendent of motive power, Eastern lines, with headquarters at Baltimore. Mr. Galloway returned to Cincinnati as superintendent of motive power, Western lines, on June 1, 1940.

JOHN WINTERSTEEN, vice-president and general manager of the Cornwall Railroad, died of heart failure at his home in Lebanon, Pa., on June 18, at the age of 65. Mr. Wintersteen was born on May 10, 1875, at Summitt Hill, Pa. He was taught the trade of boilermaking during his youth and served the United States during the Spanish-American War, as a boiler tech-



John Wintersteen

nician for ships plying between the United States and Cuba. In 1898, immediately following the war, Mr. Wintersteen entered the service of the Philadelphia & Reading as boilermaker on the Philadelphia division. From 1902 until 1906, he was employed as boiler inspector, being appointed boiler foreman in the latter year. From 1911 to 1916, Mr. Wintersteen served under the Interstate Commerce Commission of the United States Government, on the Philadelphia division of the Reading. In 1916, he became master mechanic of the Cornwall Railroad at Lebanon, being appointed general manager in 1923. In 1932, Mr. Wintersteen was elected vice-president and general manager, in which capacity he served until the time of his death. Mr. Wintersteen was a member of the New York Railroad Club.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

BENDER AND TUBE FABRICATING EQUIPMENT.—The Parker Appliance Company, 17325 Euclid avenue, Cleveland, Ohio. Bulletin No. 40 E—Instructions and price list.

◆

SAFETY EQUIPMENT.—The Boyer-Campbell Co., 6540 Antoine street, Detroit, Mich. Catalogue 40, "Equipment for Accident Prevention." Eye, face and head protection; machine-tool guards; safety tongs; clothing and gloves, etc.

◆

PORTABLE ELECTRIC TOOLS. — Skilsaw, Inc., 5033-43 Elston avenue, Chicago. Catalogue No. 41, 52 pages. Illustrates and describes complete line of Skilsaw portable electric tools and their uses.

◆

FLAME HARDENING APPARATUS. — Air Reduction Company, 60 East Forty-Second street, New York. 12-page bulletin. Describes Airco Style 4383 water-cooled flame-hardening torch and the variety of extensions and types of tips for use with it.

◆

METALLIZING EQUIPMENT. — Metallizing Company of America, Inc., 562 West Washington boulevard, Chicago. Sixteen-page booklet on Mogul Model P and S metallizing gun, and 24-page booklet on various metallizing applications, with history on aluminizing process for combating oxidation from high temperatures.

◆

AIR FILTER PANELS.—Air-Maze Corporation, 5200 Harvard avenue, Cleveland, Ohio. Twenty-page bulletin descriptive of Air-Maze filter panels for various fields.

◆

COPPER, BRASS AND BRONZE PRODUCTS.—Revere Copper and Grass, Incorporated, 230 Park avenue, New York. Handbook of tables of weights and data on copper, brass and bronze products for engineers, draftsmen, estimators and designers.

◆

KENNAMETAL TOOLS AND BLANKS.—McKenna Metals Co., 182 Lloyd avenue, Latrobe, Pa. Six-page folder, Bulletin 740, of factual data on Kennametal for machining steel of hardnesses up to 550 Brinell.

RAILWAY MECHANICAL ENGINEER

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With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, and Railway Master Mechanic. Name Registered, U. S. Patent Office.



See page 337

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September, 1940

Volume 114 *No. 9*

Locomotive:

Alco Builds Twenty D. & H. Locomotives 337

Car:

A. A. R. Truck Test Report 345

General:

Car Department Officers' Association 353
Master Boiler Makers' Association 354
Locomotive Maintenance Officers' Association 355
Railway Fuel and Traveling Engineers' Association 356
Allied Railway Supply Exhibitors 357

Editorials:

Half-Century of Achievement 358
Treated Wood for Car Lumber 358
Evidence of a Change of Mind 359
A Cost Study Worth Continuing 359
New Books 360

The Reader's Page:

The Question of Diesel Costs 361
Damaging Effects of Water in the Cylinders 361
No Place for Complacency 362
Determining Boiler Capacity 362

Car Foremen and Inspectors:

Stenciled Advertising on Freight Equipment 363
Unit Mechanically Cleans Tank-Car Interiors 364
Decisions of Arbitration Cases 366
Air Brake Questions and Answers 366

Backshop and Enginehouse:

Performance of Carboloy on Railroad Work 368
Ash Pan Hopper Castings 370
Improved Method of Applying Boiler Patches 370
Clean-Out Tool for Water Columns 371
Spring Cotter Makes Handy Scale Grip 371
Locomotive Boiler Questions and Answers 372
Improved Steam Dryer 373

High Spots in Railway Affairs 374

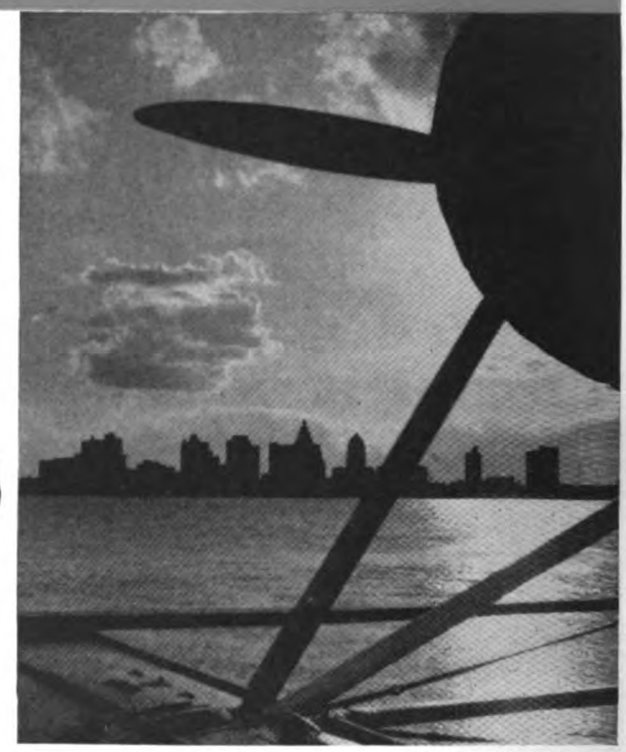
News 375

Index to Advertisers ..... (Adv. Sec.) 44

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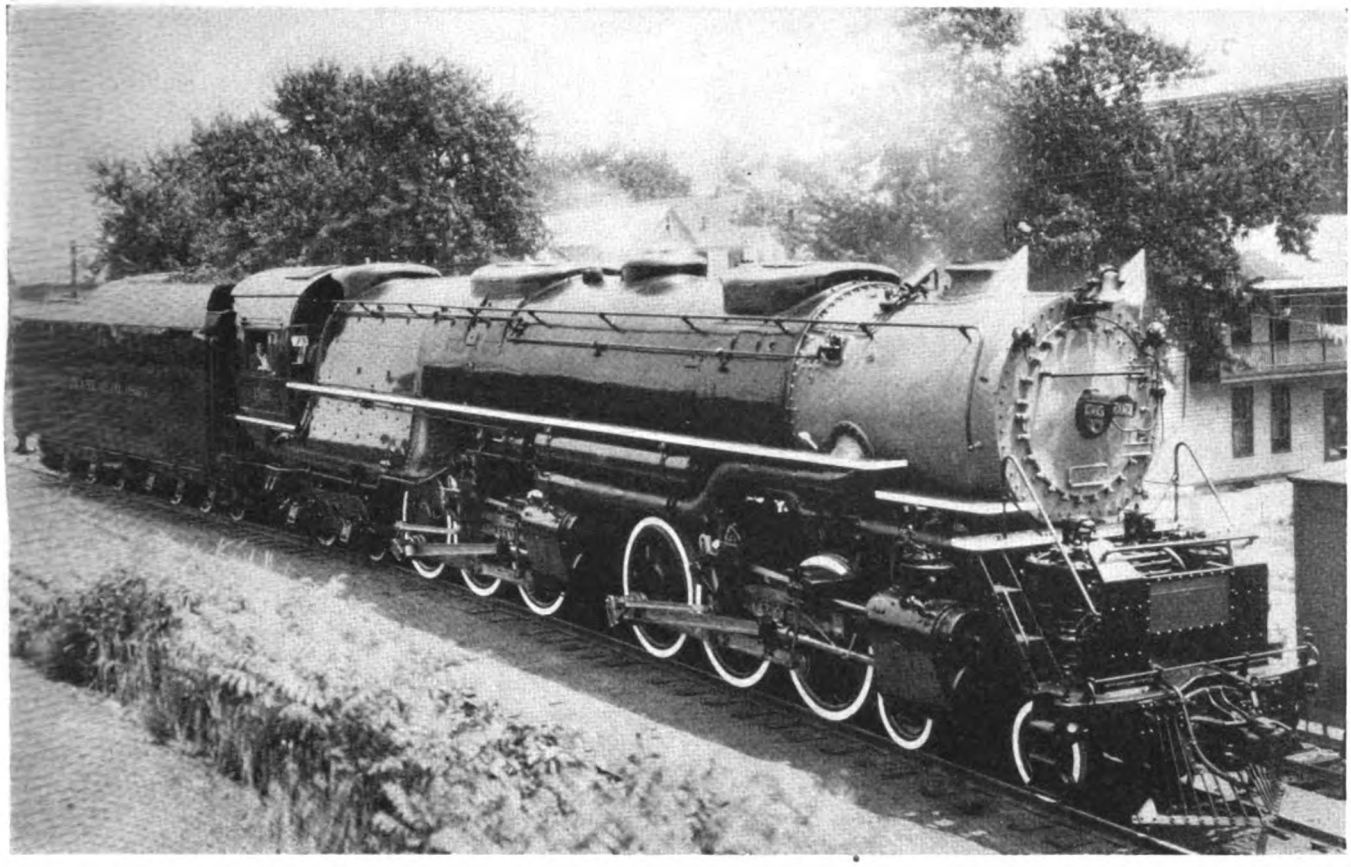
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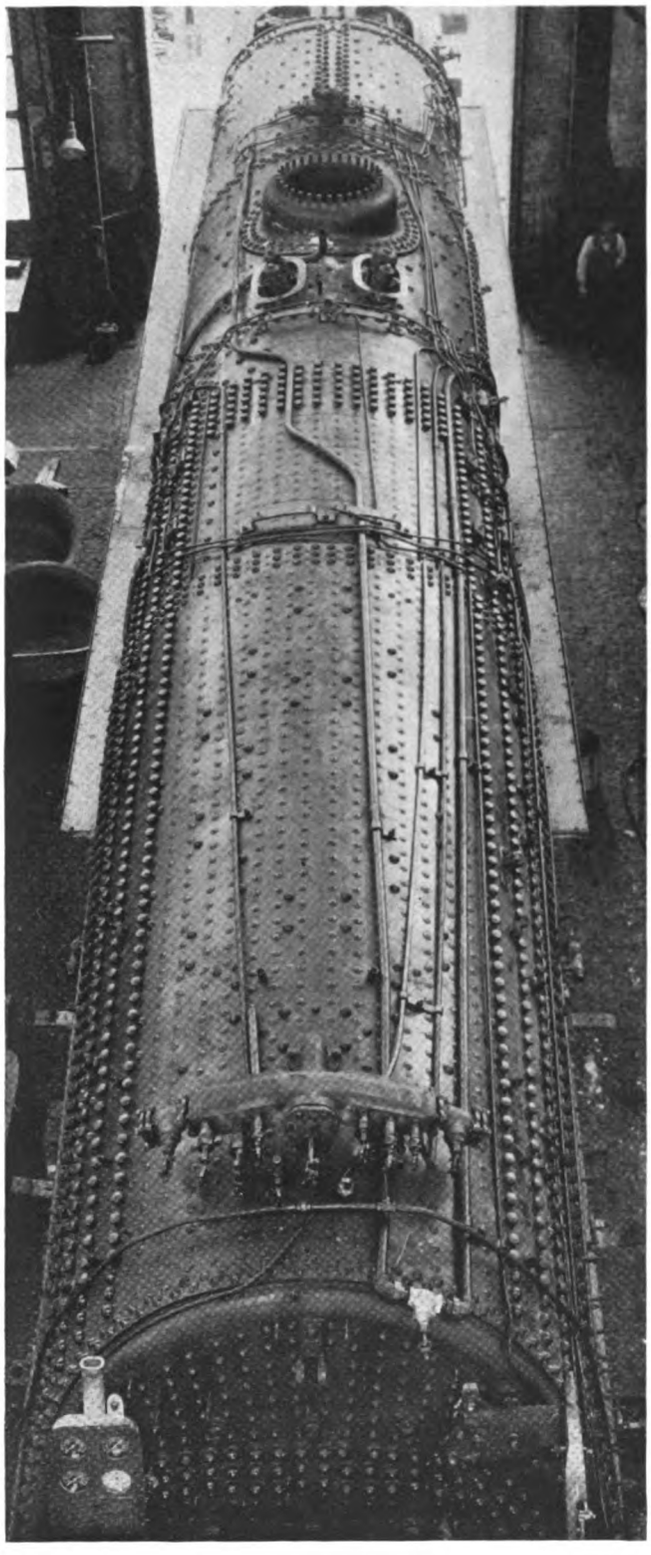
Alco builds

Twenty D. & H. Locomotives

Single-expansion 4-6-6-4 type are for fast freight service — With starting tractive force of 94,400 lb., they will effect a material reduction in double heading and helper service on a line with 1.5 per cent maximum grades

TWENTY articulated-type locomotives are now being installed on the Delaware & Hudson for high-speed, heavy freight service between Wilkes-Barre, Pa., Binghamton, N. Y., and Mechanicville, N. Y. These locomotives, built by the American Locomotive Company, are of the 4-6-6-4 type and produce a calculated tractive force of 94,400 lb. with 69-in. driving wheels.

The weight per driving axle was limited by the specification to 68,000 lb., a total specification weight allowance on drivers of 408,000 lb. The actual weight on drivers is 406,500 lb. It was further specified that the weight on the front engine was to be adhered to when the locomotive was on a 1½ per cent ascending grade. In order to accomplish this, the weight on drivers was distributed to bring more weight on the front engine than on the rear. The actual weight on the front engine drivers is 205,500 lb., while on the rear engine drivers it is 201,000 lb. The excess weight on the front engine drivers is provided to overcome slipping tendency of the front engine when ascending grades due to the surge of the water in the boiler toward the rear and other causes which reduce the adhesive weight on the front engine.



The Boiler

The boiler is of the straight-top type, 94 1/16 in. inside diameter at the first course and 102 in. outside diameter at the largest course. Barrel courses and welt strips are of Lukens carbon steel. The Elesco type A superheater has 60 5½-in. No. 8 flues of National seamless steel and 222 2¼-in. No. 12 Electrunite tubes 22 ft. long. The heating surface of the flues is 1,892 sq. ft.; of the tubes, 2,864 sq. ft., and of the superheater pipes, 1,681 sq. ft.

The firebox has a horizontal mud ring and is of welded construction, 213 1/32 in. long inside by 108 3/16 in. wide inside, with a combustion chamber 94 in. long. It has a grate area of 108 sq. ft. The heating surface of the firebox is 556 sq. ft. and that of the arch tubes 77 sq. ft. Soft coal is burned on Firebar grates fed by a Standard HT type stoker, with engine on the tender. Fire doors are Franklin No. 8. The American firebrick arch has a vertical transverse wall. It is supported on five National arch tubes 4 in. outside diameter, ¼ in. thick, which have their front ends secured in a special design thimble. Huron washout plugs and Okadee blow-off cocks are used.

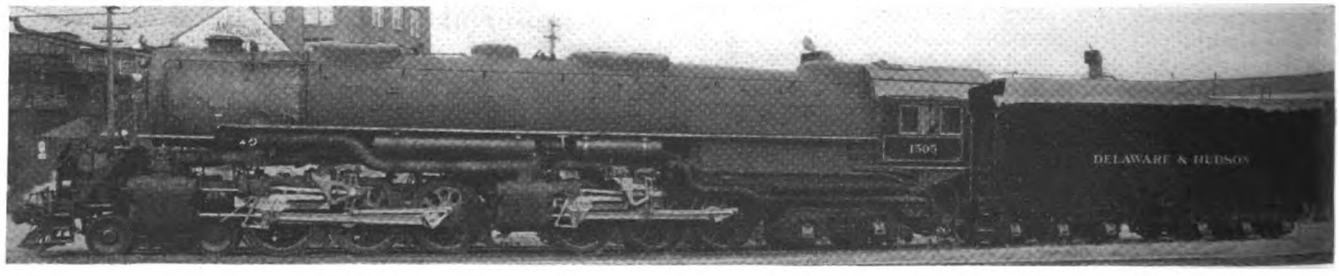
The flexible staybolts are of the Alco welded-sleeve type, of which there is a complete installation in the combustion chamber and throat sheet, except in the bottom row and in the breaking zones of the side sheets. Alco crown, radial and expansion stays are also used. Flexible stays of Ewald iron are on all of the engines, but hollow and solid staybolts of Ulster iron are on 19 of the locomotives while for one locomotive Lewis iron is used. Flexible staybolts coming inside of the cab on the back head and sides of the firebox are of the large-head, two-piece Flannery type, hollow drilled up to the head. Where flush flexibles are required, they are the small-head Flannery type.

The boiler is fed by one Hancock non-lifting type 3-W injector of 10,000 gallons' capacity located on the right side, and one Elesco No. 3 exhaust-steam injector of 12,000 gallons' capacity located on the left side. Delivery is through a Hancock twin top boiler check.

The smokebox netting arrangement is to the A. A. R. latest recommended practice, using No. 393 Draftac netting. The smokebox door is of sufficient size to permit the removal of the superheater units. The headlight is inset in the smokebox door.

The exhaust nozzle is of the Sweeney type and the smoke stack is straight, 26 in. in diameter, with the railroad company's standard shape at the top.

A steam circulating nozzle for admitting steam from the enginehouse steam line to the cold boiler is applied in the bottom of the first course near the front tube sheet. This directs steam toward the back of the boiler to promote circulation and obtain a more nearly uniform temperature all through the boiler, thus reducing the expansional stresses when firing up. Leveling brackets



A freight locomotive built by the American Locomotive Company which develops 94,000 lb. tractive force—The driving wheels are 69 in. in diameter

are applied to the left side and across the back head of the boiler, defining the center line longitudinally and transversely for checking the water level.

The Engine Beds

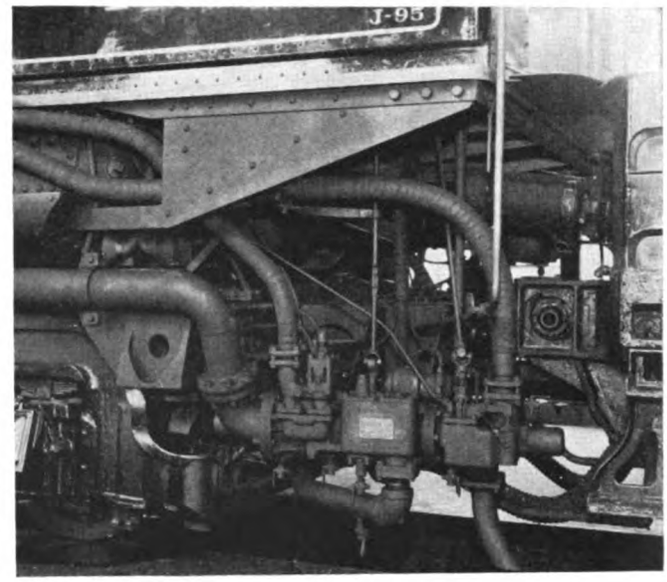
Both the front and back engine units are equipped with General Steel Castings Corporation frame beds with cylinders cast integrally. Back cylinder heads, guide yoke, valve-gear supports and air-pump supports are also integral parts of this casting.

The articulation hinge comprises a massive tongue cast on the rear of the front engine-bed unit, fitting into a cavity in the front end of the rear engine-bed unit. Bushings for the articulation pin are casehardened and ground, and hard steel wearing plates are applied above and below the hinge tongue. There is only $\frac{1}{32}$ in. clearance between the 8-in. diameter hinge pin and its bushings and only $\frac{1}{16}$ in. clearance between the wearing plates under the bottom of the hinge. Part of the weight of the rear engine unit is transmitted to the front engine unit by reason of its resting on top of the articulation hinge tongue. In the top of the hinge pin is a depression forming an oil reservoir covered by a dust cap and fed by mechanical lubrication so that oil spills down along the surface of the pin. The wearing plates on top of the tongue, which are in contact by reason of the load they carry, are grooved for oil fed from another lead from the mechanical lubricator.

By transmitting the weight of the boiler at two points on the front frame structure—namely, the main boiler bearing and the articulation hinge—perfect stability of the front frame structure is afforded with no tendency to rock as when only the main boiler bearing is the weight transferring means. This requires, however, that the spring rigging must be built with a maximum of flexibility and the engine truck equalized with the spring suspension of the front engine unit.

The Running Gear

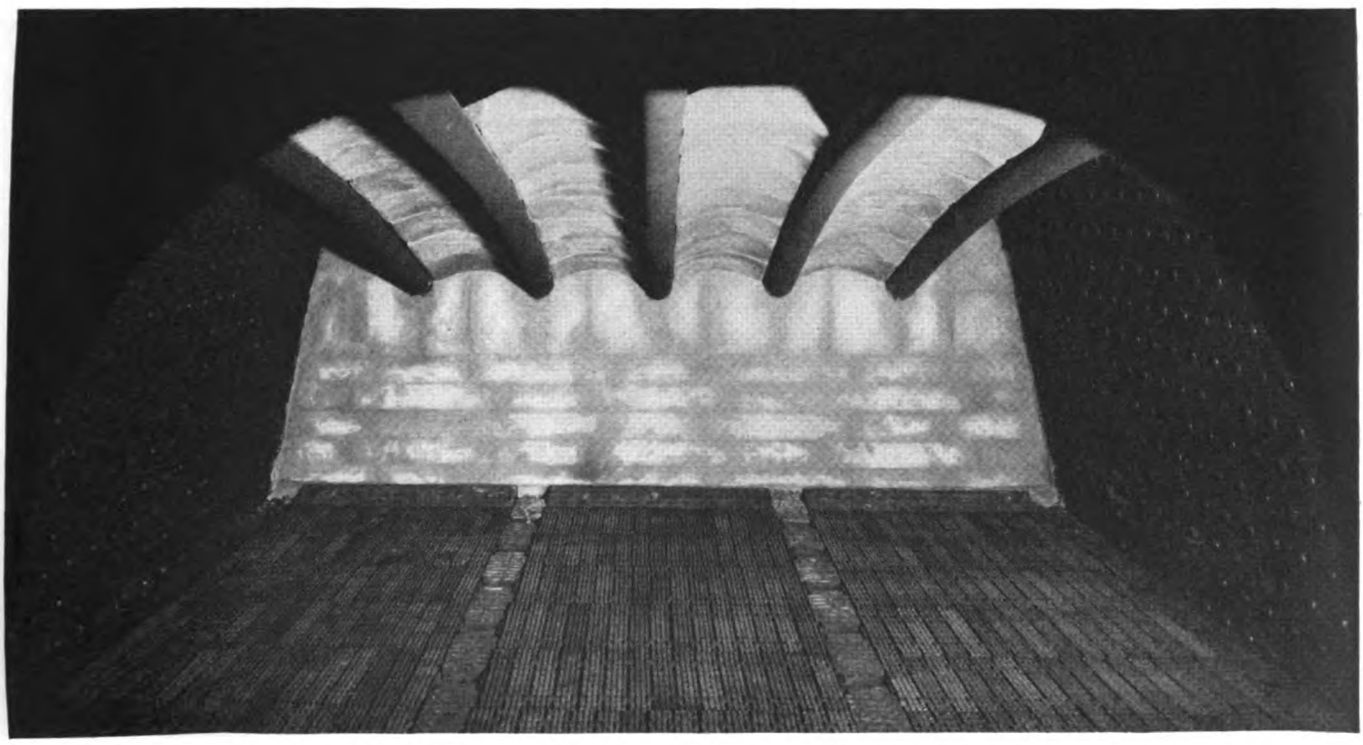
The driving wheels are of the Alco Boxpok type. The main wheels are the rear pair on each unit and



The Elesco exhaust steam injector is located under the left side of the cab—The cab is supported from the boiler

are the only pair which are cross-counterbalanced. The reciprocating weights per side amount to 1,695 lb. on the front unit and 1,540 lb. on the rear unit. The overbalance is uniformly distributed over the three wheels on each side of each unit and amounts to 172 lb. per wheel on the front unit and 157 lb. per wheel on the back unit.

The main driving axles of each unit are fitted with SKF roller bearings, while the other two pairs have plain bearings. On the plain-bearing driving boxes and trailer boxes bronze hub faces are formed by depositing Herculoy fusion rod, and the driving boxes are equipped with Franklin No. 8 grease lubricators and spreaders. To the front driving axle of each unit an Alco lateral driving-box cushioning device is applied.

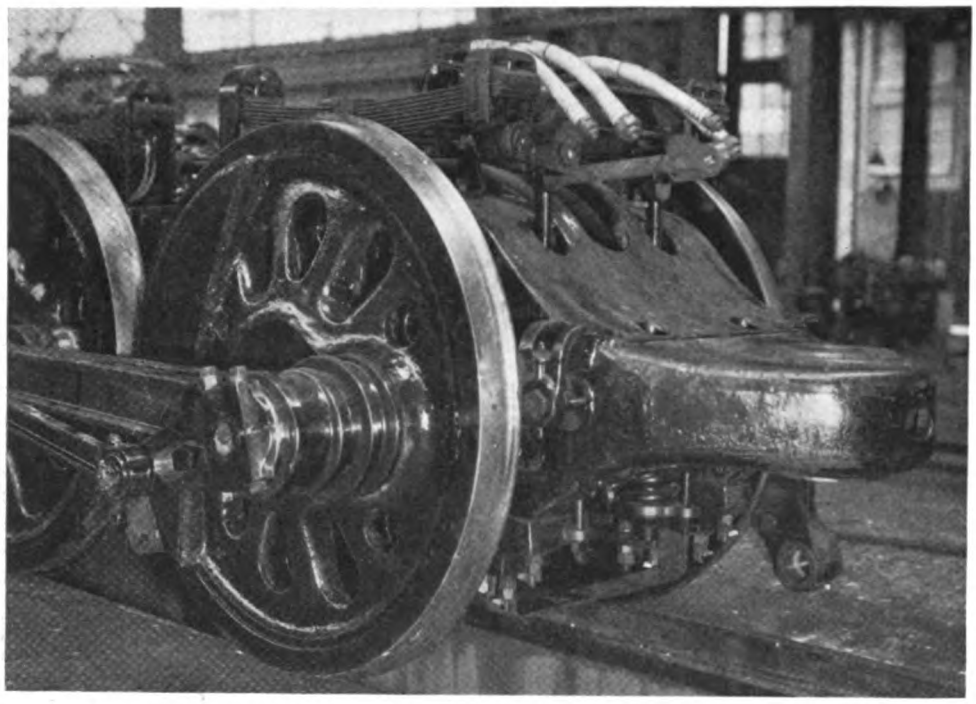


The firebox showing the brick arch, the fire wall and the Firebar grate

This permits ½ in. lateral movement on each side. The initial resistance of the lateral cushioning device on the front unit is 17 per cent and that on the rear unit is 8 per cent.

The locomotives have Alco geared roller centering-

of links and special lightweight design of eccentric cranks attached to the main crank pins with two bolts each. The eccentric rods are channeled on the outside to within 12 in. of the front ends. Alco Type G reverse gear is used with 10-in. cylinder and is connected



The hinge at the rear of the front engine unit is an integral part of the engine bed

device engine trucks providing 4½ in. swing each side of the center, with an initial resistance of 17 per cent, increasing through the first two inches of lateral movement to 33⅓ per cent and continuing constant throughout the remaining lateral-motion range. SKF roller bearings are applied to the engine-truck axles. The top halves of the bearing housings are connected transversely, while the lower halves are separate.

The trailer truck is of the General Steel Castings Delta outside-bearing type. The front trailing-truck axle boxes have a lateral movement of 1 in. each side of the center and are fitted with the Alco centering device giving 10 per cent resistance throughout its travel range. The swing of the trailing truck is 8¾ in. each side of the center. The initial resistance is 9 per cent, but builds up gradually to 17 per cent which is constant through the remaining moving range.

The shoes and wedges are of bronze. Franklin automatic wedges are applied to all driving boxes, except the main.

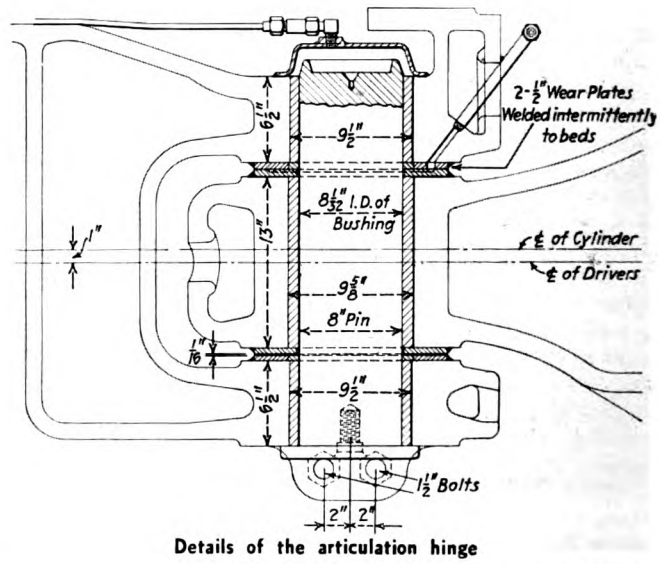
The pistons are of the box section type, made of Hunt-Spiller gun iron with Hunt-Spiller sectional duplex packing, one bronze and one gun-iron ring. Cylinder bushings and valve-chest bushings are of Hunt-Spiller gun iron. Paxton-Mitchell packing is used on both the piston rods and the valve stems. Head-to-head clearance front and back is 5/16 in.

Crossheads are of the Laird type and are arranged with the Becker design of wrist pin, removable from the outside. Side and main rods are of carbon-nickel steel, normalized, quenched and tempered. Alemite lubrication is provided for all pins, the fittings being applied in the builder's design of internal grease cavity which uses Whitworth threads for all holes tapped in the rods. Floating bushings of Magnus bronze are used on all crank pins.

Walschaert valve gear is used with trunnion design

to the reverse-shaft arm of the rear engine. The reach-rod connection to the front engine is made by a rod extending forward on the center line of the locomotive. A crosshead operating in a cylindrically shaped guide fitted into the rear cylinder saddle contains a vertical pin located exactly in vertical alignment with the articulation hinge pin to take care of the lateral swing of the front engine unit. The twelve-inch piston valves have 7½ in. travel, 3/16 in. lead, 1¼ in. lap. The exhaust clearance is line and line.

Great care was exercised to obtain free passage for the steam through the cylinders. The area through the valve-bushing ports when the piston is at the end of the stroke is 38 sq. in., or 11½ per cent of the piston area.

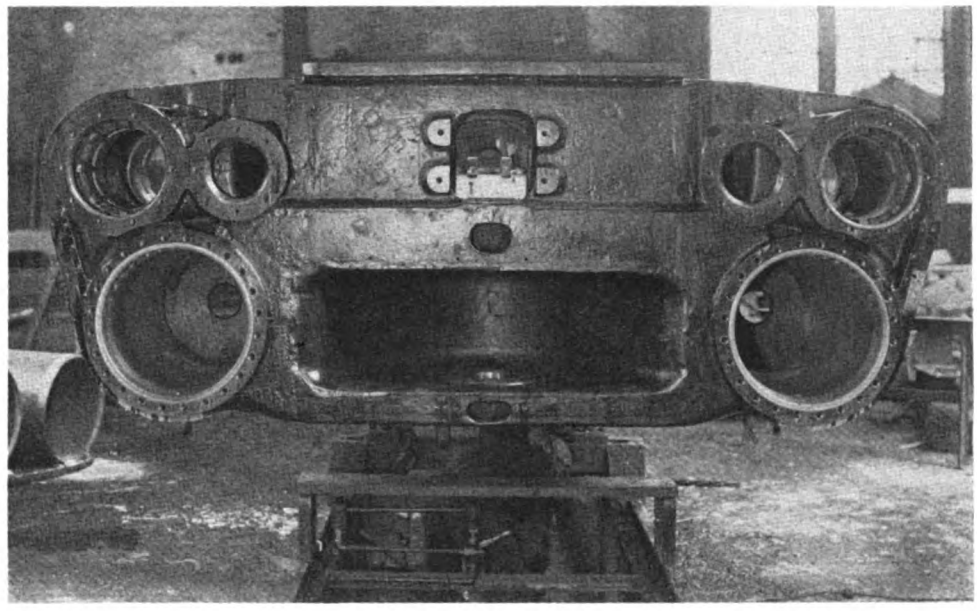


Details of the articulation hinge

Through the cylinder port the area is 34 sq. in., which is 10.3 per cent of the piston area. The clearance volume of the cylinder is 9.3 per cent.

Steam pipes are of the builder's latest non-spreading jack-knife design. An elbow with a bottom outlet on each side of the smokebox divides and directs the steam flow to the front and rear cylinders. The arrangement leading to the front cylinders is a jack-knife type, the ball joints of which provide universal movement. Soft packings are used at the cylinder connection only. All joints are mechanically lubricated. Above the steam chest of the rear cylinders the steam pipe terminates in a balanced slip joint, the slip pipe being ported and packed on both ends with Sea Ring packing. The exhaust from each of the rear cylinders extends forward in a pipe which joins on a Y-fitting at the nozzle base. The exhaust pipe from the front cylinders has the usual ball joints front and rear with a ring-packed slip joint.

Steam enters the drypipe on one locomotive through the Tangential steam dryer and on one locomotive through the Dri-Steam separator. The remaining locomotives are so designed that ready application of either type can be made.



The articulation hinge pocket in the front end of the rear engine bed

Spring Rigging and Equalization

The springing of the engine truck employs the parallel spring suspension wherein one-third of the load is carried on semi-elliptic springs and the remaining two-thirds on coils. This permits the use of a much shallower and, therefore, a much more flexible semi-elliptic damping spring, while the initial shocks are absorbed by the coils, which promotes more flexible and smoother riding qualities.

The spring rigging and equalization system are shown in one of the drawings. The driving springs are all seated on rollers with cushioning coil springs at the dead ends of the system. The rear end of the forward equalizer rests on top of a spring seat extending between two vertical hangers and bearing on coil springs. Split, shouldered bushings surround the front ends of the coil-spring hangers and rest on collars formed on their lower ends. Since these coil springs cannot be located on the center line of the frames, their hangers are attached to transverse equalizers and, except at the rear end of the forward equalizer, these coils are located just as near the inside of the frames as possible. At the front and rear ends of the spring suspension system of the rear engine unit these cushioning coil springs are arranged in tandem to give greater vertical flexibility.

No gib connections are used at the upper end of the driving- and trailing-truck spring hangers, but instead they are looped over steel castings resting on the spring end clips. Fabreeka inserts ¼ in. thick are placed under all elliptic spring end clips. All spring-rigging pins and the under sides of all loop hangers are Alemite lubricated.

Lubrication

The front engine is fitted on the right side with a Nathan DV-7 36-pint force-feed lubricator, feeding valve oil to the cylinders and valves, guides and steam-pipe ball joints (front). On the left side is fitted a Detroit force-feed lubricator feeding car oil to shoes and wedges of all pedestals, driving-box hub faces of the first two axles, flange lubricator on the front drivers, engine-truck center plate and engine-truck centering-device gear racks.

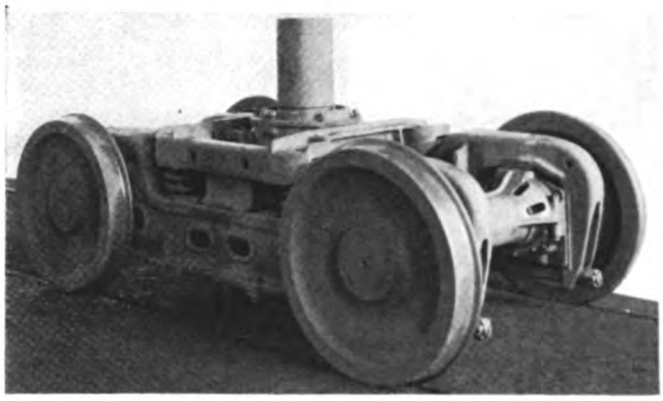
The rear engine is fitted on the right side with a Nathan DV-7 36-pint force-feed lubricator feeding valve oil to the throttle, steam-pipe ball joints (back), cylinders and valves, guides and stoker. On the left side is a Detroit force-feed lubricator, feeding car oil to the articulation hinge pin, main boiler bearing, flange lubricator on front drivers, radial buffer, all shoes and wedges on the rear engine, driving-box hub faces on the first two axles, and trailing-truck fulcrum pin.

Alemite lubrication is arranged for on all brake-hanger and spring-rigging pins, throttle rigging, bell, engine-truck pedestal shoes, the bearing points of the forward equalizer, exhaust-pipe joints, drawbar pins, rod knuckle pins, steam-pipe extension joint at rear cylinders, and reverse-gear connecting rod.

Wick-feed oilers are applied to the link trunnions and valve-rod cross-heads on top of the valve-stem guides to lubricate the top pins in the combination levers.

The Cab

The cab is supported entirely from the boiler by the builder's design of cab support and is not connected in any way with the frames. By this means the cab travels



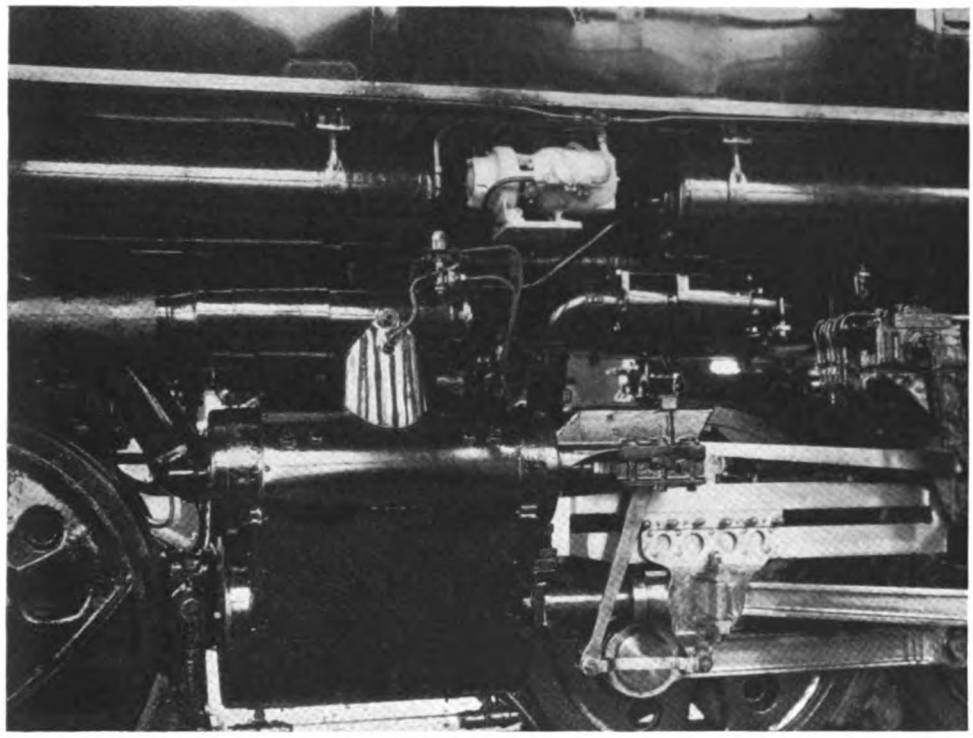
The four-wheel engine truck is cross-equalized with the driving wheels on the front-engine unit—The top halves of the engine-truck journal boxes are joined in a single casting

and a manifold-type fin-tube radiator. Sump reservoirs are placed one between the coil and the radiator and one between the radiator and the main reservoir. Into these drains the water precipitated from the air passing toward the main reservoir. An automatic drain valve opens a drain from the bottom of each sump reservoir for a brief measured time interval on each occasion that the locomotive brakes are applied, thus preventing the accumulation of water and its possible reabsorption into the air flow.

Ten of the locomotives are equipped with King type sanders, and ten with Graham-White sanders. All of the locomotives have Graham-White spreaders which are designed to keep the sand traps clear.

Tender

The tender frame is the General Steel Castings Corporation water-bottom type and the tank is of the rec-



The Becker wrist pin is applied and held by gib and wedge from the outside of the crosshead — The headlight turbo generator is mounted under the running board

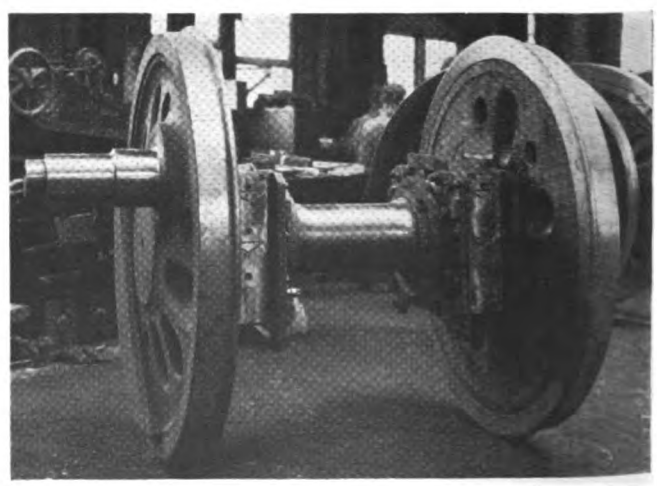
with the expansion of the boiler and no connection to the frame is subjected to movement at one end while being rigidly attached to the other. The cabs are particularly large and roomy. On the left side, back of the fireman's seat, there is a seat for the brakeman, while on the right side back of the engineman's seat is a clothes locker for the crew. The gages on the fireman's side are combined in a case having concealed illumination and through which air is circulated. A pipe extends above and below this case. At the bottom of the lower or intake pipe are right-angle bends front and rear to collect a current of air when running either forward or backward. The pipe extending from the top of the case terminates beneath the cab roof and is the outlet for this upward current of air.

Brakes

Brake operating equipment is New York schedule 8ET with two 8½-in. cross-compound compressors located on top of the frame ahead of the smokebox and operated by superheated steam. Neither the engine truck nor the trailer truck has brakes.

The air-cooling system includes a primary cooling coil

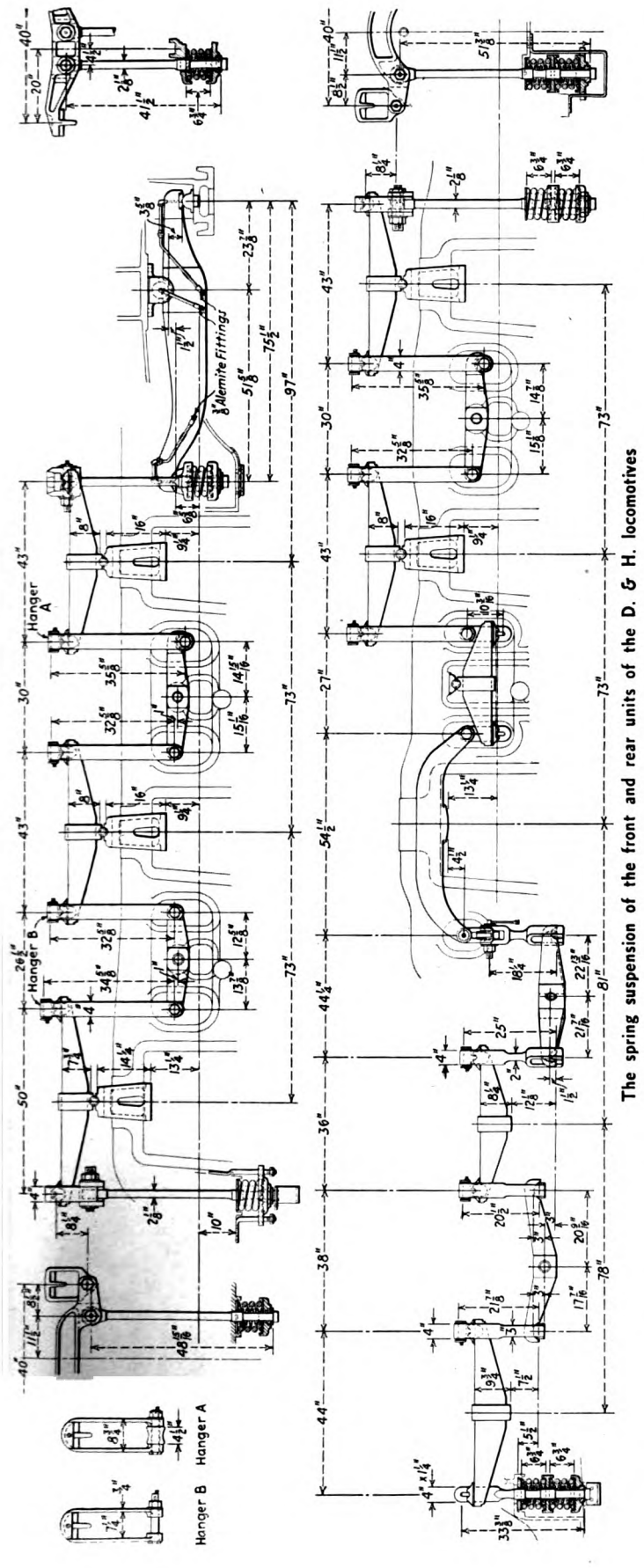
tangular water-leg type designed for 22,500 gallons of water and 26 tons of coal. The tender trucks are Gen-



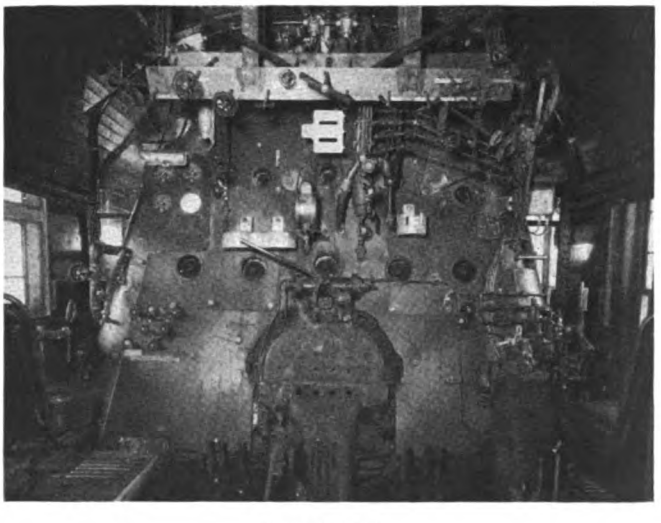
The main driving wheels are fitted with SKF roller-bearing journal boxes

General Dimensions, Weights and Proportions of the D. & H. 4-6-6-4 Freight Locomotives

Railroad	D. & H.
Builder	American Locomotive Co.
Type of locomotive	4-6-6-4
Road class	J-95
Road numbers	1500-1519
Date built	1940
Service	Freight
Dimensions:	
Height to top of stack, ft.-in.	16-2
Height to top of dome, ft.-in.	16-5½
Height to center of boiler, ft.-in.	11-0
Width overall, ft.-in.	11-3⅛
Cylinder centers, in.	92
Weights in working order, lb.:	
On drivers	406,500
On front truck	76,000
On trailing truck	114,500
Total engine	597,000
Tender	389,100
Wheel bases, ft.-in.:	
Driving	12-2
Engine, total	59-11
Engine and tender, total	103-6
Wheels, diameter outside tires, in.:	
Driving	69
Front truck	36
Trailing truck:	
Front	36
Back	45
Engine:	
Cylinders, number, diameter and stroke, in.	4-20½x32
Valve gear, type	Walschaert
Valves, piston type, size in.	12
Maximum travel, in.	7½
Steam lap, in.	1¼
Exhaust clearance, in.	Line and line
Lead, in.	3/16
Boiler:	
Type	Straight top
Steam pressure, lb. per sq. in.	285
Diameter, first ring, inside, in.	94 11/16
Diameter, largest, outside, in.	102
Firebox length, in.	213 1/32
Firebox width, in.	108 3/16
Height mud ring to crown sheet, back, ft.-in.	11-0
Height mud ring to crown sheet, front, ft.-in.	7-0¾
Combustion chamber length, in.	94
Arch tubes, number and diameter, in.	5-4
Tubes, number and diameter, in.	222-2¼
Flues, number and diameter, in.	60-5½
Length over tube sheets, ft.-in.	22-0
Net gas area through tubes and flues, sq. ft.	105.9
Fuel	Bituminous coal
Stoker	Standard HT
Grate type	Firebar
Grate area, sq. ft.	108
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	556
Arch tubes	77
Firebox, total	633
Tubes and flues	4,756
Evaporative, total	5,389
Superheater	1,681
Combined evap. and superheat.	7,070
Exhaust steam injector	Elesco No. 3
Tender:	
Type	Water bottom
Water capacity, gal.	22,500
Fuel capacity, tons	26
Trucks	Six wheel
Journals, diameter and length, in.	7 x 14
Rated tractive force, engine, 85 per cent, lb.	94,400
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	68
Weight on drivers ÷ tractive force	4.31
Weight of engine ÷ evap. heat. surface	111.0
Weight of engine ÷ comb. heat. surface	84.58



The spring suspension of the front and rear units of the D. & H. locomotives



The cab interior

Boiler proportions:	
Firebox heat. surface, per cent comb. heat. surface	8.95
Tube-flue heat. surface, per cent comb. heat. surface	67.27
Superheater heat. surface, per cent comb. heat. surface	23.78
Firebox heat. surface ÷ grate area	5.86
Tube-flue heat. surface ÷ grate area	44.03
Evap. heat. surface ÷ grate area	49.90
Superheater heat. surface ÷ grate area	15.57
Comb. heat. surface ÷ grate area	65.47
Net gas area, tubes-flues ÷ grate area	0.98
Tractive force ÷ grate area	874.2
Tractive force ÷ evap. heat. surface	17.52
Tractive force ÷ comb. heat. surface	13.35
Tractive force × dia. drivers ÷ comb. heat. surface	921.3

eral Steel Castings Corporation six-wheel equalized type with 7-in. by 14-in. journals, 36-in. rolled-steel wheels, Miner rocking roller type side bearings, and American Steel Foundries clasp brake. Miner type A-22-XB draft rigging is used with National Malleable couplers and A. A. R. swivel yokes. The Franklin E-2 radial buffer is fitted between the engine and tender. Barco Type 3-VX flexible joints are installed between the engine and tender on the air-brake train line, the tender-brake-cylinder connection, the stoker-engine steam line, and other flexible pipe connections.

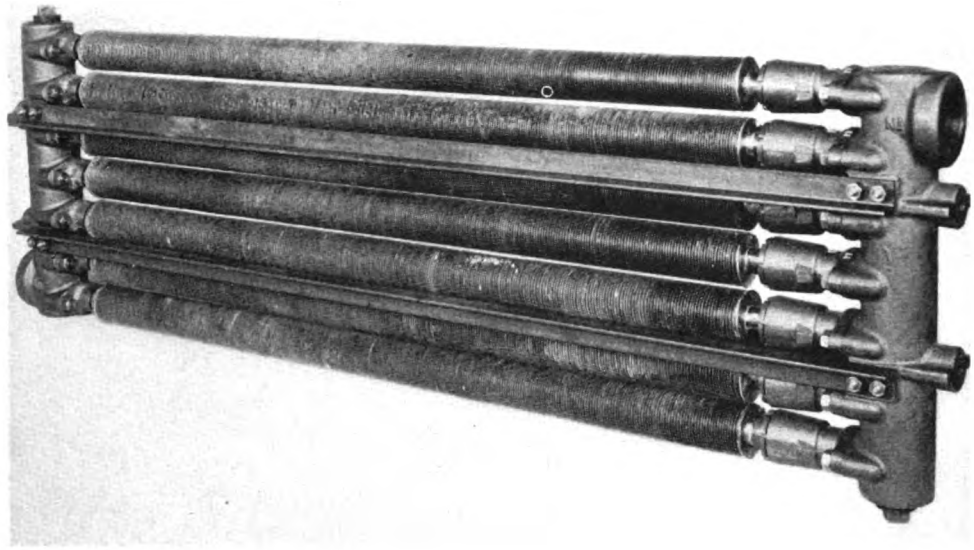
All piping extending along the boiler is concealed under the jacket, only the throttle pull rod and hand rail being visible. The sand traps are likewise placed under the jacket and the sand-box steps when not in use fold up flush with the jacket. The smokebox is also tapered $6\frac{9}{16}$ in. All of these provisions, together with the use of a top boiler check, were made to secure the best possible vision ahead for the enginemen.

The Character of the Line and Service

The line between Wilkes-Barre and Mechanicville is 215 miles long. The lines from Wilkes-Barre and Binghamton converge at Nineveh, 93 miles north of Wilkes-Barre and 24 miles north of Binghamton. Between Wilkes-Barre and Nineveh the maximum grades are 1.5 per cent. Northbound, the maximum grades between Binghamton and Mechanicville are slightly over one per cent. Southbound, they are about 1.4 per cent.

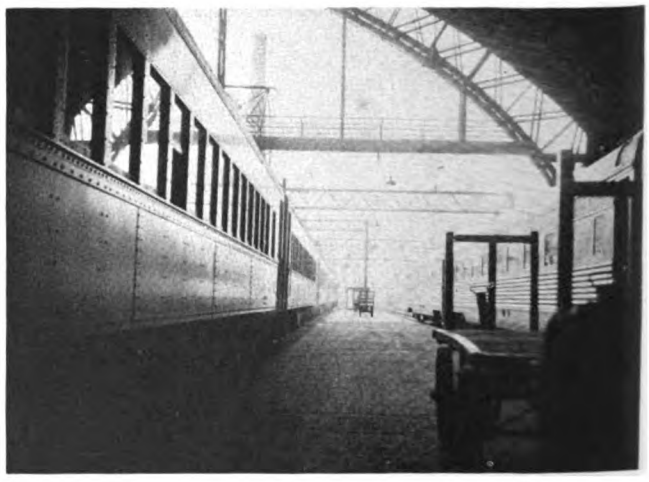
From the southern end of the Wilkes-Barre line originates a large tonnage of anthracite coal which moves north toward Canada and New England. Between Wilkes-Barre, Binghamton and Mechanicville there is a considerable movement of manifest freight which has increased greatly in volume during the past few years. The increasing necessity for maintaining schedule deliveries to connecting roads has made imperative the employment of modern motive power suitable to meet this requirement, often operating under adverse conditions.

Prior to the delivery of the articulated locomotives, the D. & H. operated exclusively in this service consolidation types of much less individual power, a condition which required for the distance between terminals an unusual amount of helper service and double heading. The driving wheels of the consolidation type locomotives in this service are 57 in. and 63 in. in diameter, and counterbalance conditions for the high rotative speeds required were not all that could be desired. The adoption of this Mallet type locomotive with 69-in. driving wheels has solved many of the past operating difficulties insofar as decreasing track stresses through shorter rigid wheel base and better counterbalance conditions are concerned.

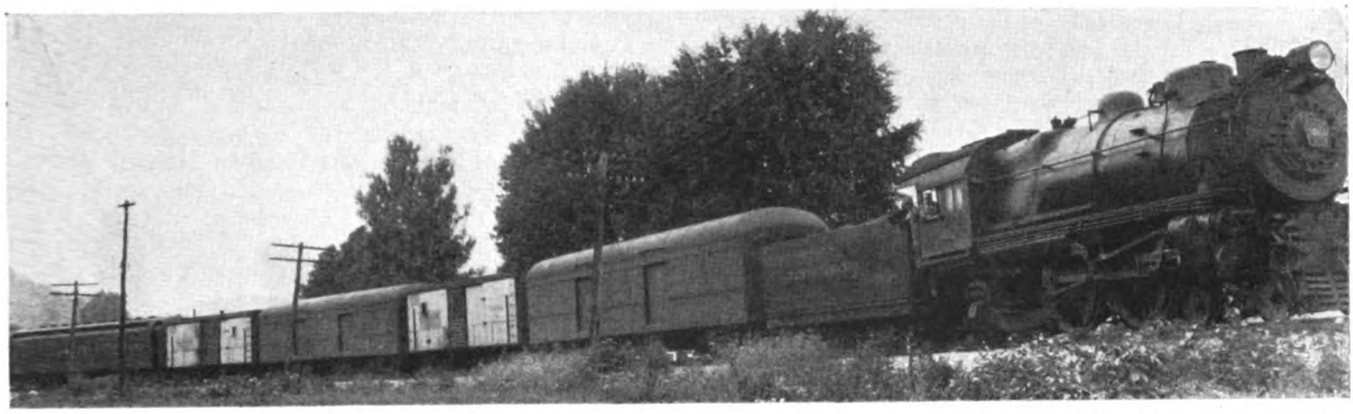


The fin tube radiator of the main reservoir air-cooling system is equivalent to more than 50 ft. of 2-in. pipe—It is 6 ft. long by 1½ ft. high

* * *



Looking north from within the big train shed at Reading terminal, Philadelphia, Pa. The "Crusader" has just arrived at the right and a multiple-unit electric train at the left is about to leave for the suburbs



Train used for A. A. R. high-speed freight car truck tests

A. A. R. High-Speed Freight Car

Truck Test Report

Most comprehensive truck tests ever conducted by the railroads —Individual trucks not rated, but report shows the advantages and the limitations of each

In the latter part of 1938, at the request of the vice president of the Operations and Maintenance Department of the Association of American Railways, the General Committee considered the investigation of trucks for high-speed freight service and at its meeting held on November 16, 1938, "It was decided that this subject should be referred to the Committee on Car Construction with instructions to co-operate with the Committee on Brakes and Brake Equipment, the Committee on Wheels, and W. I. Cantley, mechanical engineer, in an investigation of trucks for high-speed freight service, and, if necessary, make tests covering all phases of the problem, including brakes, wheels, etc."

In accordance with the foregoing, the Committee on Car Construction appointed a subcommittee consisting of W. A. Newman, chief mechanical engineer, Canadian Pacific; J. McMullen, superintendent car department, Erie; F. A. Isaacson, engineer car construction, A. T. & S. F.; J. T. Soderberg, general foreman, Pennsylvania and T. M. Cannon, engineer car construction, C. M. St. P. & P. R. R. The purpose of the investigation was to aid in the study of the problems involved. The data secured would then be available for use in designing and building freight car trucks suitable for high speed.

The A. A. R. sub-committee met on January 11, 1939, to formulate plans for procedure. It was decided that the scope of the investigation would be: (1) To determine whether the conventional freight truck is safe to operate at high speeds—i. e. 80 m. p. h. or over and has satisfactory riding qualities at 80 m. p. h. or over; also (2) To determine riding qualities and performance of trucks designed specifically for the above high speed service.

At its first meeting the A. A. R. sub-committee decided that the method of procedure would be to conduct tests under actual service conditions by operating different trucks in a high speed train and measuring their performance. Aside from differences in design of trucks it was proposed specifically to investigate the effect of differences in track, differences in load, and differences in wheels.

On January 12, 1939, there was held a joint meeting of the A. A. R. sub-committee, representatives of the A. A. R. brake and wheel committees and representatives of the various truck manufacturers, at which time the different manufacturers were invited to furnish free of charge a car set of trucks which they had developed for high speed service or which they had in the process of development. The trucks were to be furnished for 5½-in. by 10-in. journals and have physical dimensions making them suitable for installation under the test cars. The trucks were to be furnished without wheels and axles, journal bearings and wedges, and were to be equipped with plain side bearings. They were to be assembled and tried out in service before being offered for test. Complete drawings were to be furnished, with the understanding that if in the opinion of the subcommittee the trucks were unsafe for high speed operation they would be rejected for test. The manufacturers were advised that only one design of truck could be entered by one manufacturer, and that the truck sides and bolsters were to meet the A. A. R. specifications for strength. Ten different truck manufacturers had representatives present at this meeting and they all indicated that they wished to co-operate to the fullest extent in this investigation.

The sub-committee at first proposed to use both rolled steel and cast iron wheels in testing these trucks. It was contemplated testing the trucks with each kind of wheel, first, in the as-rolled or cast condition which comes within the A. A. R. tolerances, and second, with the wheels ground so that treads were truly round and concentric with the journals. It was also contemplated making some tests with wheels that had developed hollow treads from wear in service. Further consideration of the subject resulted in a decision to test only with concentric wheels and eccentric wheels, both of which had been ground so as to be truly round, and use only

steel wheels. It was felt that the round concentric wheels would represent the best wheel condition to be encountered in service and the round eccentric wheels would represent a bad wheel condition which would be the same for all trucks tested.

In order to investigate the influence of differences in track the sub-committee realized that it would be advisable to select a test site that would have different kinds of track over which the test train could be operated. The test site finally selected included both main line passenger track which was probably in as good condition as any track in the country and also branch line track which was good sturdy track but which did not have the maintenance that the main line track had.

The question of loads was decided from consideration of the empty weight of the test cars and the capacity of the trucks tested. After all the instruments were installed in the cars it was found that the lowest rail weight that could be obtained was 58,000 lb. For the heaviest load the customary limit of 85 per cent of axle limit load for express service was adopted, which gave the highest rail weight as 145,000 lb.

The final test program decided upon was as follows: Each truck to be given one round trip with concentric wheels and loads of 58,000 lb., 83,000 lb., 113,000 lb., and 145,000 lb. rail weight. Each truck was then to be given one round trip with eccentric wheels and the same loads.

Classification System for Trucks Entered in A. A. R. High-Speed Freight Truck Tests

A. = Integral Journal Box Trucks—side frame is unsprung weight
- I = Designs with springs located in an opening at the center of the side frame
  - 1—A. A. R.
  - 2—A. S. F.
  - 3—National
  - 4—Ohio
  - 5—Railway
- II = Design with springs located at various positions
  - a. = Spring groups in parallel
    - 1—Buckeye
    - 2—Simplex
  - b. = Spring groups in series
    - 1—P. R. R. No. 1
    - 2—Scullin

B. = Separate Journal Box Trucks—side frame is sprung weight
- 1—Barber
- 2—Full Cushion
- 3—Symington

The sub-committee reserved the right to discontinue tests on any truck if at any time it appeared to be unsafe for operation at these high speeds.

The 12 trucks tested and the sponsor of each were as follows: (1) A. A. R. Truck—the conventional design of spring plank truck, equipped with 1936 plain coil springs. These trucks were secured from the stock of the Pennsylvania. (2) A. S. F. truck—furnished by the American Steel Foundries, (3) Barber truck—furnished by the Standard Car Truck Company, (4) Buckeye truck—furnished by the Buckeye Steel Castings Company, (5) Full-Cushion truck—furnished by the Allied Railway Equipment Company, (6) National truck—furnished by the National Malleable & Steel Castings Company, (7) Ohio truck—furnished by the Ohio Steel Foundries, (8) PRR No. 1 truck—furnished by the Pennsylvania, (9) Railway truck—furnished by the Railway Truck Corporation, (10) Scullin truck—furnished by the Scullin Steel Company, (11) Simplex truck—furnished by the Bettendorf Company, (12) Symington truck—furnished by the Symington-Gould Corporation.

(Each one of these trucks was described in detail on the report with photographs, drawings, spring group characteristics and a list of parts with weights. Following the descriptive section there was a classification system for the various trucks, based mainly on the arrangement of the springs in the truck and considered helpful in evaluating the relative worth of the different designs. —EDITOR)

Location and Equipment Used in Making Tests

These tests were made on the Pennsylvania between Altoona, Pa. and Lock Haven. From Altoona to Tyrone, a distance of 14.2 miles, is main line track; from Tyrone to Lock Haven, a distance of 54 miles, is branch line track that is maintained for heavy freight service and branch line passenger trains. Headquarters for the tests were located at the Altoona Car Shops of the Pennsylvania, where the work of building and installing the trucks was performed. A day's test consisted of a trip from Altoona to Lock Haven and return. Practically all of this track is laid with new 130 and 131-lb. rail in 39-ft. lengths, there being only a very short stretch in each track laid with cropped rail. It is rock ballasted all the way and is maintained in first class condition. Battered joints are periodically built up by welding and the surface of the rail is ground at intervals to remove any corrugation that may have developed. The curves are super-elevated, and regular passenger trains are given a 70 m.p.h. speed limit on this track with a restriction to 15 m.p.h. from Grazier eastward to beyond Tyrone. The test train was given a speed limit of 85 m.p.h. on the stretch from Altoona to Grazier. Most of the test runs started and stopped at RO Tower, but on account of operating conditions it was necessary to start a few runs from the passenger station. The test train left the eastbound passenger main at milepost 223.4 to cross over to the branch, and it arrived back on the westbound passenger main from the branch at milepost 129.7, which gave a little more than a half mile running in this stretch that was not on the passenger mains and was done under a restriction of 15 m.p.h.

The Bald Eagle branch, extending from Tyrone to Lock Haven, is a single track line with passing sidings operated under controlled manual block system. Mileposts are numbered from Tyrone. The rail is all relaid 130-lb. section, some being 39-ft. lengths and some being cropped rail. It is rock ballasted throughout and is good track, but it does not receive the maintenance that the main line track receives. The curves are not super-elevated. Regular passenger trains are given a speed limit of 60 m.p.h. on this branch. Before these tests were started the track was given special attention so as to make it safe for the test train to attain a speed of 85 m.p.h. over certain stretches.

Regular stops for inspection of equipment were scheduled at Tyrone and Milesburg in each direction and at Lock Haven for turning the locomotive on the wye and putting it on the other end of the train. The test train was given a regular schedule which was adhered to as closely as operating conditions would permit. The train was operated on a clear block throughout the entire distance in order to permit making the same speed schedule on each run. On the main line operation was controlled by automatic block system. On the branch line it was controlled by manual block system with operators located at Park, Port Matilda, Milesburg, Wood and Lock Haven. In September traffic on the branch line increased to such an extent that operators were stationed at Eagle and Hall towers; at first intermittently and later regularly. Hand signals were used to control operation from these two towers.

A normal speed chart for both directions of running is shown in this report. For convenience the profile and speed diagrams are given on the same page for the same stretch of track. The goal for operation of the test train

was to duplicate speed as closely as possible on successive runs and to do as much running as possible at speeds above 60 m.p.h. The problems encountered in the operation of freight cars at speeds up to 60 m.p.h. are pretty generally understood as a result of tests conducted by the Association of American Railroads in 1933, and methods of solving these problems are known. In order to do any substantial amount of running at high speeds, it was necessary to attain those high speeds as quickly as possible after starting. The desired speed schedule over each stretch of track was made as high as curves and grades would permit, the theory being that if a truck performed satisfactorily at the highest speeds it would perform satisfactorily at lower speeds. It was known that some freight trucks exhibit critical speeds below 60 m.p.h. and it was suspected that critical speeds above 60 m.p.h. might be found. One of the jobs of the observers riding the test cars was to watch for the exhibition of these critical speeds.

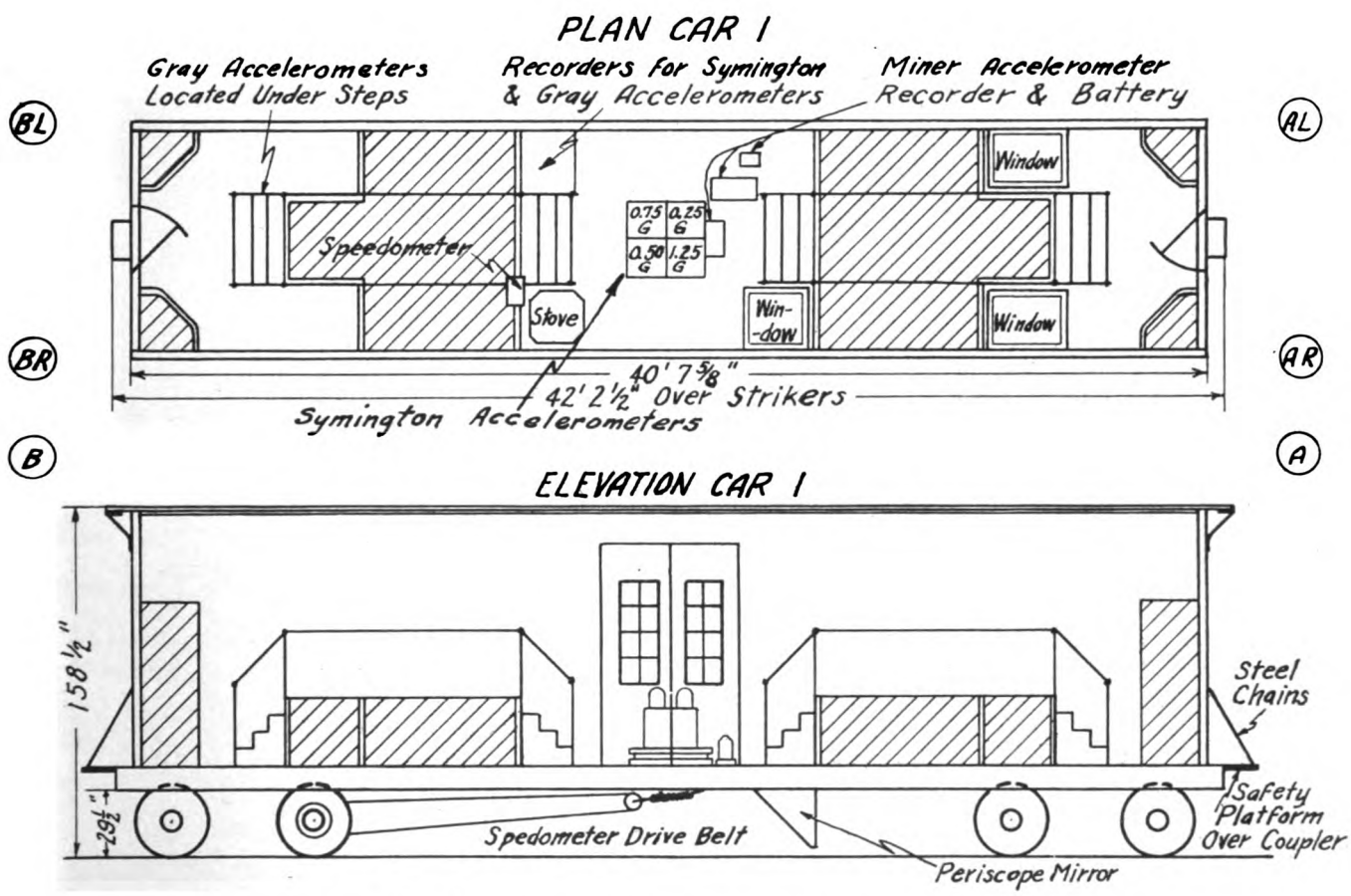
The first test run was made on June 1, 1939, this being a preliminary run to try out the set-up. Several more preliminary runs were made and the regular program was started on June 16, 1939. Throughout the first series of runs, which included every truck at the light load, runs were made every other day in order to give each manufacturer an opportunity to approve the assembly of his trucks. The test train was operated with extra crews during this period but the road foreman of engines or his assistant rode the engine and controlled operation. On July 17, 1939, a regular crew was assigned to the train and from then on runs were made on every week day except when load was being changed, and the same engineman handled the throttle on all runs. The regular program of tests was completed on October 20, 1939.

The Test Train

One illustration shows the test train at one of its stops on an eastbound run. The consist is locomotive, baggage car, test car No. 1 which carried the base truck used as a measuring stick, baggage car, test car No. 2 which carried the truck being tested, and passenger coach; a total of a locomotive and five cars.

The locomotive was Pennsylvania No. 3002, an Atlantic type, designated as E-6-s by the Pennsylvania. The wheel arrangement is 4-4-2, the drivers being nominally 80-in. in diameter. The rated tractive force is 31,275 lb. This is a fast locomotive which is used for light passenger service. It was hand fired. It had been given classified repairs just before the start of these tests and was assigned to the test train when it came out of the shop. It was used for every test run made. A Weston speedometer was installed to guide the engineman in running. The magneto was mounted on the right side of the pilot and driven by a spring belt from a wooden grooved pulley attached to the right front pilot wheel. The speedometer indicator was placed in the cab in front of the engineman's position.

The baggage cars and coach were carried to place the test cars between cars which would remain unchanged throughout the progress of the test and therefore always subject them to the same influence of the coupled car. They also served to bring the braking power of the train within requirements for passenger train operation, as the freight cars were low in braking power when heavily loaded. The passenger cars were braked to 90 per cent of their light weight and the freight cars to 73 per cent of their stenciled light weight of 46,400 lb., with 50-lb. brake cylinder pressure in both cases. This high figure for the freight cars was attained by changing the body levers as much as possible to stay within the



Schematic drawing showing arrangement of one of the test cars

strength of the brake beams when getting a passenger emergency application. The coach also served as headquarters for the train crew. All three of the passenger cars were equipped with four wheel passenger trucks having 5½-in. by 10-in. journals and steel wheels. The baggage cars were Pennsylvania standard 60-ft. cars, light weight 101,000 lb. The coach was 70 ft. long, light weight 130,000 lb. The front baggage car was used to charge the spare storage batteries used in operating the test instruments. A connection was taken off the regular car batteries for this purpose, the regular generator on the car furnishing current to keep the car batteries charged.

The middle baggage car was fitted up as an office and work car. Facilities were provided for repairing and calibrating instruments, as well as performing the paper work in connection with the tests. This car also gave storage space for some of the smaller pieces of equipment and tools, etc., used in connection with the tests. During the last part of the runs with eccentric wheels the recorders for the Gray accelerometers were located in this car. After the weather became cold it was equipped with a coal-burning stove. Instrument cables from Test Car 2 to Test Car 1 passed through the middle baggage car, holes being cut in each end for this purpose. These cables were provided with connectors for parting when it became necessary to break up the train to work on the test cars.

The two test cars were from a lot of several hundred 50-ton cars originally built for the Delaware, Lackawanna and Western. Car No. 1 was built in March, 1928 and Car No. 2 was built in August, 1927. These cars have steel underframe, superstructure and ends, with wood siding.

In order to fit them for test purposes they were provided with doors in each end for passage between the cars. The regular steel side doors were blocked in open or partly-open position and glazed wooden doors installed to facilitate entrance and exit. Extra steps and grab irons were provided at the side doors. Observation windows about 12 in. square were placed in the sides of the cars. These were accessible from seats inside the car and were fitted with angular mirrors to afford a view along the side of the train in both directions while running. The interiors of the cars were fitted with lading bins to confine the lading and leave free floor space for instruments and observers. Three windows were placed in the floor of each car to afford a view of the trucks while running. Two of these windows were located in one end of the car and the third was located near the center. The end windows were on each side over the inside wheels of the truck where they afforded a view directly down on the truck. The center window was located to the side of the car and was equipped with a mirror placed on an angle underneath the car floor so as to give a view looking at the inside of the truck. One of the drawings shows in plan and elevation the arrangement of the various features of test car No. 1. Both test cars were equipped with air signal lines, signal valves, emergency brake valves and passenger triple valves to make them acceptable for operation in passenger service.

The corner lading bins were constructed from ¼-in. thick steel plate bolted into place on angle irons, and were provided with a removable hatch to facilitate loading. The framework for the main lading bins was made of angle iron bolted to the car floor and sides, and the steel partition sheets were bolted to this framework. The tops of these bins were covered with removable planking to provide a central passageway through the cars, this passageway being guarded by a hand rail. Steps were provided at each end of the passageway to reach the level of the tops of the lading bins. An interior view of each car is shown in Figs. 40 and 41.

The stenciled light weight of Car No. 1 was 47,900 lb. and for Car No. 2 it was 46,400 lb. After all the instruments were installed and Car No. 1 was equipped with the PRR No. 1 truck and Car No. 2 with the AAR truck, the cars were weighed. It was found that Car No. 1 weighed 57,360 lb. and Car No. 2 weighed 53,360 lb., the increase over the stenciled light weight coming from the addition of lading bins, instruments, etc. Sufficient lead was put in the corner lading bins of each car to bring the weight to 58,000 lb. which was then used as the lightest test weight. In running tests no attention was paid to the variation in weight of the different trucks installed on Car No. 2.

Wheels

New wheels were used throughout for these tests, secured from the stock of the Pennsylvania. They were 33-in. one-wear steel wheels with reinforced flange and 1¼-in. rim. After mounting on the axles the treads were ground to give the desired contour and concentricity and to get the same tape size on both wheels of a pair. The taper used on the tread was the A. A. R. standard of 1 in 20.

For preparing the eccentric wheels a recessed cap was fastened on each end of the axle, these caps having centers $\frac{3}{64}$-in. eccentric with the bore of the cap where it fitted the axle end. They were fastened to the axle with cap screws tapped into the ends of the axle, care being used to locate the caps so that the high points on the two ends of the axle would match. The axle wheel seat was machined with the axle carried on the two cap centers, this resulting in the wheel seats being $\frac{3}{64}$-in. off center with the journals which were machined with the axle mounted on its own centers. The wheels were then mounted on the axle and the treads were ground with the axle mounted on the cap centers. The tapped holes in the axle ends were filled with lead after the machine work was done.

In order to facilitate changing trucks under Car No. 2 three sets of concentric wheels and three sets of eccentric wheels were prepared. This gave one set to use under Car No. 1 and the other two sets were used alternately under Car No. 2, one set being installed on the trucks for the next day's run while the other set was being used for a run. The wheels were marked so as to be always installed in the same position under the car, and each make of truck was always equipped with the same set of wheels every time it was assembled. Six sets of journal bearings were provided, and these were marked so that they could always be applied to the same journal. Care was used in handling the wheels so as not to nick the treads or journals, and in operating the train so as not to produce slid flat spots.

Instruments

Most of the performance of the different trucks was determined by measuring the shocks they delivered to the body of the car while in motion. These measurements were supplemented by the observations of men riding the cars to watch the action of the car and trucks while in motion, and who inspected the trucks at each stop.

Car No. 1 was equipped with a Valve Pilot speedometer which indicated speed and also drew a speed chart of the run. This speedometer was driven from the No. 2 axle of the car by means of a long rubber V belt passing over a split pulley mounted on the axle and over the speedometer drive pulley which was located under the car floor. This drive pulley was mounted on a pivoted arm to which was attached an extension coil

spring to maintain tension on the drive belt. The drive pulley was connected to the speedometer registering mechanism located inside the car by means of a flexible shaft running inside rigid metal conduit.

In order to determine if any springs went solid lead wires were applied at the points which would touch, wherever this was possible. Lead wire $\frac{1}{16}$-in. in diameter was used for this purpose. In some cases where it was impossible to use this wire the surfaces which would touch were painted with a rather heavy coat of quick drying paint. In other cases the trucks were fitted with push gages which would indicate the maximum motion of the parts during the preceding stretch of running. These devices were examined at each stop for indications or records of springs going solid.

The shocks delivered to the car body were measured by accelerometers attached to the car body. Three different designs of these instruments were used in order to secure as much data as possible. All three of these designs used the same principle of operation, in that each had a series of guided weights of uniform mass, each held against a stop by a spring, the pressure of which could be nicely graduated. Whenever a weight was subjected to a shock which was heavy enough to overcome the pressure of the spring holding it against the stop the weight would move away from the stop until the shock had passed, when it would return to its position against the stop. Some form of electrical indicating or recording means was provided to show the number of times each weight moved away from its stop during a run. By setting the pressure of the spring to a different value for each weight in the instrument the shocks occurring could be separated out into any desired range of values. This form of accelerometer is known as a "Contact Accelerometer." It is wholly free of errors caused by the weight spring getting into resonance with the shocks which occur because its indications are taken from the fact that the weight moves away from the stop and not from the distance it moves. Each weight can respond only to shocks which are heavy enough to overcome the pressure of its spring, and whenever such shocks are not present the weight is held in its neutral position against its stop.

(At this point the report included a description and illustrations of the Miner, Symington and Gray Accelerometers, the three different designs which were used in the tests.—EDITOR.)

Method of Conducting Tests

By nature, this was a competitive test. Any manufacturer who had a car set of trucks which he thought was satisfactory for high speed service was privileged to enter them, subject only to the opinion of the subcommittee as to the safety of the trucks and the requirements that the parts should meet the A. A. R. specifications for strength, and that the trucks should have been previously assembled and operated in service. It was, therefore, necessary to keep the conditions as nearly as possible constant throughout the test in order to guard against favoring one truck or penalzing another.

The use of a special train with clear block signals gave a good measure of control over the speed at which the train would operate, but there were variables in the weather and in the condition of the track from day to day caused by maintenance. It was also realized that small differences in speed from day to day might have an appreciable effect on the performance of a truck so it was decided that the only fair way to test would be to use one of the trucks as a base truck and test all the other trucks against it. One test car would be equipped with the base truck and the other car would be equipped with the rest of the trucks in turn, with the loading, wheels, instruments, etc. in the two cars as nearly alike as it was possible to make them. The PRR No. 1 truck was selected as the base truck because it had been tried out in high speed service and also because it was not sponsored by a manufacturer of trucks. The A. A. R. truck was not selected as the base truck since it could not be expected to perform satisfactorily at speeds of 80 m.p.h. or over.

The location of the different accelerometers in one of the test cars is shown in a drawing. The Symington accelerometer weight units were located in the center of each car, being mounted on a cast steel base plate which was large enough to accommodate four units. This base plate was fastened to the car floor with lag screws and the weight units were bolted to the plate. The size of these weight units makes them practically non-portable, and the position of the individual units was not changed during the test. Their calibration was checked at frequent intervals between runs, and always whenever there was reason to suspect that it might have changed. Very little trouble was experienced with the spring pressure getting out of calibration but there was considerable difficulty in keeping the switches adjusted to give the proper weight travel before the switch opened. The counters and batteries for all of the Symington accelerometers were located in Car No. 1.

The Miner accelerometer weight units were located near the center of each car. A base plate made of $1\frac{1}{2}$-in. thick boiler steel was fastened to the floor with lag screws in a position next to the Symington base plates and centered laterally. The Miner instruments were bolted to this base plate, with the weight guide arms extending crossways of the car. The recorder and battery for each instrument were located close to the weight unit. The Miner weight units and recorders were interchanged between test cars at Lock Haven each day in

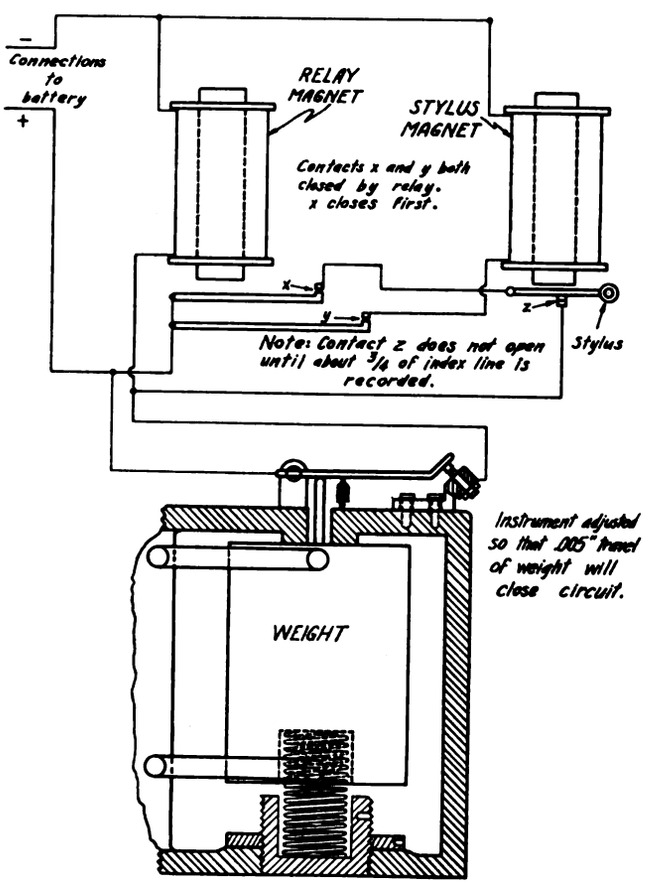


Diagram of Miner accelerometer

order to eliminate the effect of any possible difference in the instruments. These instruments were calibrated at frequent intervals between runs, and always when-

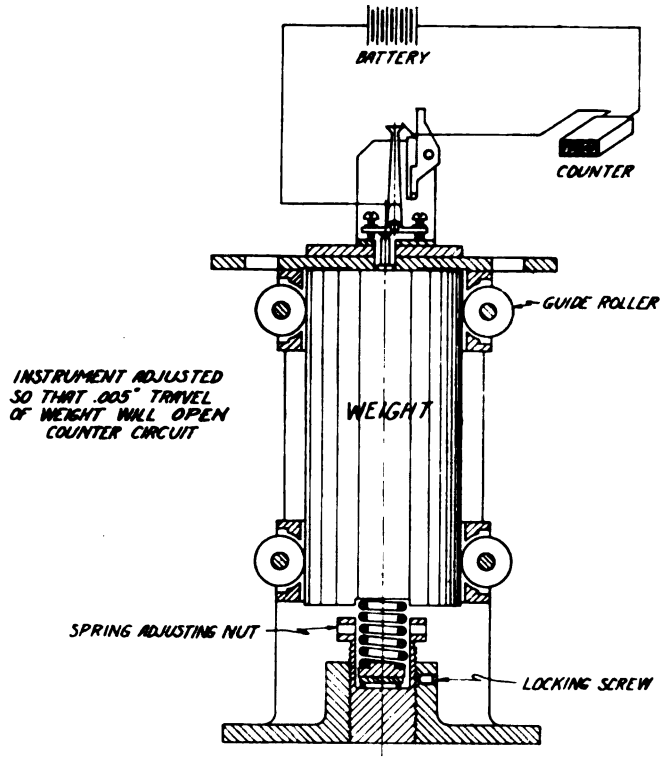


Diagram of Symington accelerometer

ever there was reason to suspect that they might have changed calibration.

The Gray accelerometers were located in the end of each car directly over the bolster. A base plate made from 1½-in. thick boiler steel was fastened to the floor with lag screws and the instrument cases were bolted to this plate. One vertical instrument and one lateral instrument were used in each car, this being all the instruments available. Their calibration was checked at frequent intervals, just as for the other accelerometers. These instruments were not interchanged between cars regularly as were the Miner instruments. Each day at Lock Haven the instruments were reversed on the base plate because the vertical instruments should be installed with the weight pivots leading, and reversing the lateral instruments gave an opportunity to investigate lateral forces in the direction opposite that investigated on the eastbound trip. This was merely an attempt to compensate for lack of sufficient lateral instruments. The tube units, batteries, counters and chart recorders for all Gray accelerometers were located in Car No. 1 until Run No. 118 was completed, when they were moved to the middle baggage car. This change was made because the eccentric wheels caused a chatter in Car No. 1 that made the chart record almost illegible.

The order in which the tests were run also served to keep conditions more comparable for the different trucks. This order was decided upon to expedite the conduct of the tests. A few preliminary runs were made to try out the set-up and familiarize the test crew and train crew with the work. Car No. 1 was equipped with the base truck and Car No. 2 was equipped with the A. A. R. truck for these preliminary runs, the last one of which was used as the official run for the A. A. R. truck under these load and wheel conditions. All trucks were then tested under these same conditions, since it involved less time and expense to change trucks than it did to change load. This arrangement had the advantage of testing the different trucks under more nearly comparable conditions of weather and track and skill of train and test crews. During the first series of tests with concentric wheels and 58,000 lb. rail weight a test run was made every other working day, the intervening days affording an opportunity to assemble the truck for the next run under the supervision of a representative of the manufacturer and also to go over the instruments thoroughly. Track maintenance on the branch was increased during this time in accordance with the reports of the crew of the test train, so that a high speed schedule could be attained on the branch. The engine and train crews were from the extra list, but all of the running was done by the road foreman of engines or his assistant. Beginning with the second series of tests, in which the load was increased to 83,000 lb. rail weight, a regular train crew was assigned and all running after that was done by one engineman.

Shop Work

While the test train was making a run a crew of shop men would build the trucks for the next day's run, using the wheels from the trucks tested the previous day. The same crew was always used for this work to insure proper assembly of the trucks. Upon arrival at the shop, test Car No. 2 would be placed on a track having overhead crane facilities for changing trucks. After installation of the next trucks the side bearing clearance was set to ⅛-in. per side and the brake cylinder piston travel was checked to see that it came within limits of 7 to 7½-in. The journal boxes were then packed, using new passenger type packing each time. A liberal coating of oil had been applied to the journal bearings when they were installed. The test train was then made up for the next day's run. The trucks removed were torn down the same afternoon in order to inspect them for

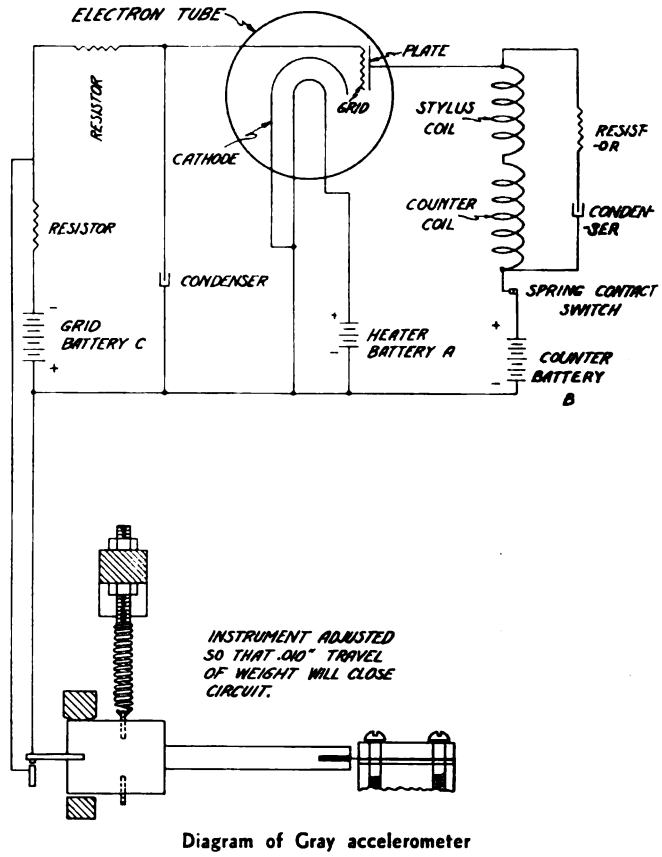


Diagram of Gray accelerometer

possible necessary repairs before using the parts or wheels again.

For loading the cars, lead pigs weighing about 35-lb. each were used. These had the advantage of being easily handled, although it took considerable time to handle enough of them to make the required change in load. They occupied small space for a given weight, thus not interfering with space required for instruments and observers. They gave a lower center of gravity than would be obtained with most commercial loads, which fact would probably make the car bodies more stable from the standpoint of rocking. The load was arranged the same way in both cars and an effort was made to keep the distribution as nearly uniform over the floor surface as possible.

(At this point the report included an explanation of the test data secured and an interpretation of these data, followed by 84 pages of detail performance data for the various types of trucks tested.—EDITOR.)

Discussion of Results

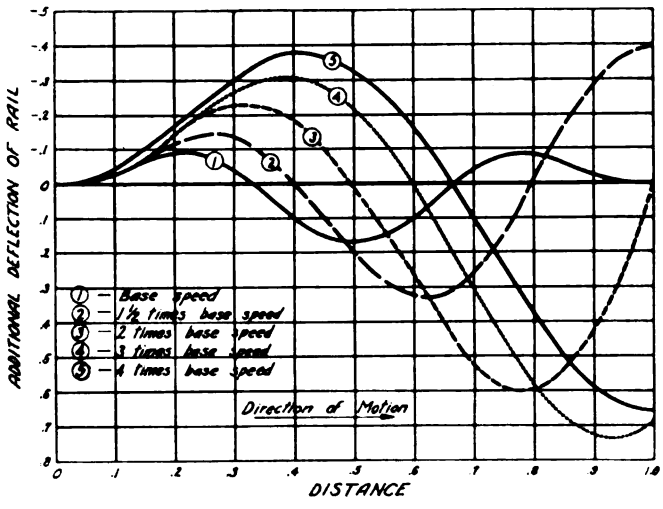
It has been known for a number of years that freight cars equipped with plain coil springs have critical speeds —i. e. certain speeds at which they ride worse than they do at either lower or higher speeds. The fundamental cause of this action is resonance. Some disturbance is received by the car which is periodic, meaning received at regularly repeated intervals. If the period of these disturbances coincides with the period at which the springs will naturally oscillate the conditions for resonance exist and a large amplitude of oscillation of the springs will be built up and a rough ride will follow. No one of the disturbances by itself would have much effect in giving a rough ride, but a number of these small disturbances repeated at regular intervals can result in a very rough ride. Freight cars are subjected to two pronounced periodic effects as they move along the track. The first of these comes from the wheels, as every complete revolution of a wheel causes a repetition of any variation in effect it may have as it revolves. Eccentricity and flat spots are the worst offenders encountered. The second periodic effect comes from the rail joints because rail lengths are substantially uniform and the distance between joints is covered in equal intervals of time at uniform speed. The speed at which resonance will occur depends upon the time of natural vibration of the springs, and this is determined by the deflection of the springs under the load they are carrying. It will thus be seen that the critical speed or speeds for any car will depend upon the load it is carrying at the time.

It so happens that the critical speed of average freight cars so far as wheel action is concerned is somewhere around 25 m.p.h. It is rather narrow in range, sometimes being only about two m.p.h. wide. Its location and narrow range make it unimportant from an operating standpoint, but this statement does not mean that it can be ignored. The critical speed from rail joints is somewhat higher than from wheels, and is wider in its range. It may be as wide as 10 m.p.h., and seems to occur at speeds between 40 and 50 m.p.h. Because of its width its effect may be felt at speeds from 35 m.p.h. up to 55 m.p.h., depending upon the load in the car, and sometimes at even higher speeds. Stiff springs and light loads cause it to occur at higher speeds. The effect that this critical action produces on the car body depends upon the amplitude of spring oscillation which is built up. If this is large a heavy shock may be produced by each bounce. The amplitude of oscillation will build up until it is sufficient to absorb the energy delivered to the car body by the wheel or rail joint disturbance. Fortunately, it can be reduced by using springs which have a higher energy-absorbing rate than plain coil springs. There are a number of designs of friction springs or snubbers that have proved adaptable for this purpose. Every truck in this test, with the exception of the A. A. R. truck, had some device incorporated in the spring suspension to raise the energy absorption rate to take care of this critical action. There is doubtless some minimum energy absorption rate which will satisfactorily control this action, and experience points to a figure of about twenty per cent absorption. It should be mentioned that if the absorption means unduly increase the stiffness of the spring system more harm than good may be done.

It has been thought that there may be other critical speeds higher than those mentioned above, or in other words that freight cars would exhibit this action of critical speeds in the ranges above 60 m.p.h. There is no periodic action except that of wheels and rail joints to cause the occurrence of critical speeds, and the maximum effect from both of these causes occurs at speeds below 60 m.p.h. Shocks occur at speeds above 60 m.p.h., and they may be severe if the truck is not suited for these speeds, but they are caused by the dynamic effect of individual low spots in the track rather than by the cumulative effect of a number of small disturbances repeated at regular intervals. The cars were especially watched for critical speeds by the observers who rode them, and the charts from the Miner and Gray instruments were thoroughly examined for indications of them in assembling the information given in the report under the "Detail of Observations." The only indication of anything critical at speeds above 60 m.p.h. was the high frequency vibration of Car No. 1 and the fact that some trucks seemed to ride better at 80 m.p.h. than they did at lower speeds. While this high frequency vibration might be considered critical in the sense that it seemed to be associated with a definite speed, yet it was not the same kind of action that is generally thought of when referring to critical action of freight cars. The fact that some trucks seemed to ride better after passing speeds in the neighborhood of 75 m.p.h. may be said to demonstrate the existence of non-critical speeds, which implies the existence of critical speeds. This action, however, can be explained from an effect different from periodic disturbances.

It is well known that track differs in its smoothness, this being essentially a function of maintenance. It is not the smoothness that is apparent to the eye when looking at the track that is so important, as it is the different change in surface at the different points of the rail as a train passes over it. All track must yield some under the wheel loads, and the most perfect track is the one which yields uniformly throughout its length. If it were possible to secure track like that there would be no need for springs on a freight car, because the vertical position of the car would not change as it rolled along. The impossibility of securing that kind of track dictates the use of springs to modify the shocks that result from track irregularities causing change in the vertical position of the car body. A mathematical analysis of the action of track and springs under moving cars is too complicated to be entered into a report such as this, but it can be stated that it shows that there is one speed where the effect of a low spot in the track is maximum, higher speeds producing less disturbance in the track and consequently less disturbance in the car body.

A simple illustration of this is given in the chart of curves showing the dynamic effect of low spots on rail, which has been taken from page 336 of Timoshenko and Lessells' text book "Applied Elasticity." Their nomenclature has been changed to make the illustration of the point clearer. The text book authors derive these curves



Curves showing dynamic effect of low spots (Timoshenko-Lessells)

in connection with the solution of the problem of stresses produced in track by the effect of low spots. They have simplified the problem in its presentation and point out certain cautions in connection with its application, but these do not detract from the value of the curves to illustrate the point that speed alone has a variable effect on the disturbance resulting from any track irregularity. No specific values are given on the curves shown here because they are intended to illustrate only a broad principle and are not to be applied to specific cases. In the chart, horizontal distances represent position along the track, the left hand edge of the graph corresponding to the start of a low spot, and vertical distances represent the additional deflection of the rail produced by the effect of the low spot, these being negative above the base line and positive below it. This additional deflection is in addition to that produced by the static action of the wheel load. Each curve gives the additional deflection produced at different points along the rail at one condition of speed. To distinguish these curves from each other they have been numbered from 1 to 5. Curve 1 represents any particular speed, curve 2 a speed at 1½ times as great, curve 3 twice as great, curve 4 three times as great and curve 5 four times as great. In the words of the authors "It should be noted that at the instant the wheel reaches the edge of the low spot the pressure on the rail and the deflection begin to diminish while the wheel begins to accelerate in a downward direction. Then, the retardation of this movement begins and with it the increase in pressure and deflection, as seen from the figure." This variation in rail deflection, and with it the pressure, is what produces the shock to the car body. It can be seen from the curves that the effect is less at higher speeds than it is at some lower speed, curve No. 4 showing the maximum positive additional track deflection and rail pressure, which occurs at a point reading about .92 on the track position scale. The popular expression puts it quite tritely which says if you run fast enough you jump over the low spots in the track.

Summary of Results

It is evident that the majority of the trucks were entered in this test more on faith in their performance at high speed than on actual knowledge of it. No particular criticism can be attached to this because there was not a great amount of knowledge of the condition encountered in high speed service prior to the running of these tests. It should be remembered that failure of any of these trucks to perform satisfactorily at speeds as high as 85 m.p.h. does not condemn them for service at lower speeds. The dividing line seems to be about 60 m.p.h.

One of the outstanding facts developed in these tests is that snubbers which have proved to be the solution of the problem of controlling oscillation at speeds below 60 m.p.h. are of little, if any, value at speeds above 60 m.p.h. The reason is easy to understand. The oscillation that occurs at speeds below 60 m.p.h. builds up from small impulses regularly repeated, while the troubles experienced at speeds above 60 m.p.h. come from individual track irregularities each one of which produces a very damaging shock unless the spring system is capable of modifying it. The usual snubber is something which is placed under the truck bolster to absorb energy during movement of the spring group. Its very presence in the spring system makes the springs more sluggish in their operation and this is the last thing desired in high speed trucks. Spring systems for high speed trucks must be lively and capable of making the wheels follow the rails with as little variation as possible in the wheel pressure on the rail. After passing over a track irregularity they must quickly return to their neutral position so as not to be in an unfavorable position when the next irregularity is reached. There must be a certain amount of absorption in the spring system to damp motion quickly and to take care of the periodic impulses encountered at lower speeds, but the degree and character of this absorption must be kept within much narrower limits for high speed trucks than for low speed trucks. The first action of a spring system in passing over a low spot at high speed is to open rather than to close, and any interference with this action is detrimental.

These tests show that softer springs are the real solution of the high speed truck problem, and the softer they are the better the results secured. The limitations in coupler height variation and the large variation between empty and fully loaded weights of freight cars place limitations on the maximum spring travel which can be incorporated in freight trucks, but very few of the trucks in this test took full benefit of the spring travel which could be used. Another difficulty exists in the use of long travel springs in compression, and that is the fact that lateral stability decreases with increased travel. Failure to provide for this in truck design may result in insufficient horizontal stability.

This question of proper horizontal stability is very important from the standpoint of safety of operation at high speed. The lateral action of the wheels is pronounced at high speed and this results in an unsquaring force on the truck. If the truck does not offer sufficient resistance to this unsquaring action it might become great enough to cause derailment. Failure to control it properly results in bad lateral shocks to the car body even if it does not approach the derailing point, and this is cause for unsatisfactory performance.

(The report included highly important supplementary information in the form of Appendix I, covering tests with resilient side bearings; Appendix II, additional modified truck tests; and Appendix III, measurements of rail stresses during the high-speed freight truck tests. —EDITOR.)

INCREASED RAILROAD SHIPMENTS.—More rail shipments of Nova Scotia coal to Central Canada may be in the offing, according to a recent statement by the Dominion Coal Administrator. It is pointed out that because of the war, coal-carrying ships available for the transportation of fuel from Cape Breton to Upper Canada via the St. Lawrence are being diverted into other activities and if the traffic is to be handled it must be handled by rail.

Car Department Officers' Association

Hotel Sherman, Chicago

Tuesday, October 22

Morning Session

8:00 o'clock Registration.

10:00 o'clock Address by Col. Robert S. Henry, assistant to president, Association of American Railroads. (Joint meeting of co-ordinated associations).

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11:00 o'clock Meeting called to order.

11:05 o'clock Approval of minutes of last annual meeting.

11:15 o'clock President's address.

Afternoon Session

1:30 o'clock Reports of Membership Committees:
Northeast District—A. J. Krueger, general chairman.
Southeast district—E. S. Smith, general chairman.
Southwest district—F. E. Cheshire, general chairman.
Northwest district—G. R. Andersen, general chairman

2:30 o'clock Report of Secretary-Treasurer.

3:30 o'clock Report of unfinished business.
Report of new business.

Wednesday, October 23

Morning Session

9:00 o'clock Report of Publicity Committee—E. L. Woodward, western editor, Railway Mechanical Engineer, chairman.

10:00 o'clock Address: Importance of the car department in the function of rail transportation, by J. M. Symes, general manager, Western Lines, Pennsylvania, and second vice-president, Indianapolis Union Ry.

10:30 o'clock Report of Freight and Passenger Car Construction and Maintenance Committee—D. J. Sheehan, superintendent motive power, Chicago & Eastern Illinois, chairman.

11:15 o'clock Report of Shop Operation, Facilities and Tools Committee—J. A. Deppe, superintendent car department, C. M. St. P. & P., chairman.

Afternoon Session

1:30 o'clock Report of Passenger Train Car Terminal Handling Committee—E. J. Hollahan, general car foreman, Illinois Central, chairman.

2:15 o'clock Report of Lubricants and Lubrication Committee—J. R. Brooks, supervisor lubrication and supplies, Chesapeake & Ohio, chairman.

Thursday, October 24

Morning Session

9:00 o'clock Report of Freight Car Inspection and Preparation for Commodity Loading Committee—F. J. Swanson, general car department supervisor, C. M. St. P. & P., chairman.

10:00 o'clock Address: Car maintenance, performance and expense, by O. A. Garber, chief mechanical officer, Missouri Pacific Lines.

10:30 o'clock Report of Interchange and Billing for Car Repairs Committee—M. E. Fitzgerald, master car builder, Chicago & Eastern Illinois, chairman.

Afternoon Session

1:30 o'clock Report of A.A.R. Loading Rules Committee—H. H. Golden, supervisor of A.A.R. interchange and accounting, L. & N., chairman.

Friday, October 25

Morning Session

9:00 o'clock Report of Painting Committee—C. L. Swing, general foreman, Pullman-Standard Car Mfg. Co., chairman.

10:00 o'clock Report of Booster Committee—Brad S. Johnson, sales engineer, W. H. Miner Inc., chairman.

10:30 o'clock Report of Reception Committee—W. J. Demmert, sales agent, Griffin Wheel Co., chairman.

11:30 o'clock Suggestions for good of the association.

Afternoon Session

2:00 o'clock Report of the Nominating Committee—J. E. Keegan, chief car inspector, Pennsylvania, chairman.
Election of officers.

Master Boiler Makers Association

Hotel Sherman, Chicago

Tuesday, October 22

Morning Session

8:45 o'clock Registration*
10:00 o'clock Joint meeting of the Co-ordinated Associations.

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10:45 o'clock President's address.
Remarks by L. B. Rhodes, president, Allied Railway Supply Association.

Afternoon Session

1:30 o'clock History of the Association by John A. Doarnberger.
Address by Dr. Edward C. Elliott, president, Purdue University.
Topic No. 2. Pitting and corrosion on firebox sheets and rivet heads
Discussion of topics for 1941 meeting

Wednesday, October 23

Morning Session

9:45 o'clock Business session.
Address by M. A. Quinn, general master mechanic, Delaware, Lackawanna & Western.
Topic No. 5. Application of iron, steel and alloy rivets with recommendations for heating and driving.
Illustrated paper by Ray McBrain, engineer of tests, Denver & Rio Grande Western, on Effects of service on carbon and alloy steel in the boiler and firebox and the aging of the material.

Afternoon Session

1:30 o'clock **Topic No. 3.** (Continued from 1939)—Improving circulation in the locomotive boiler—Increasing feedwater temperature—Deterimental effects on circulation due to improper firing practices—Proper firing up and cooling down of boilers—Design of new boilers to improve their water-carrying properties.
Secretary-Treasurer's report.
Committee on Law.

Thursday, October 24

Morning Session

9:30 o'clock Address by a railroad officer.
Topic No. 1. Use of acetylene and electric processes in the boiler shop.
Paper with illustrations by a committee of the International Acetylene Association, on Use of oxy-acetylene cutting and welding in the boiler shop.
Paper with illustrations by W. G. Theisinger, welding and metallurgical engineer, Lukens Steel Co., on Heat and mechanical stresses in welding and the forming and rolling of heads and plates.

Afternoon Session

1:30 o'clock **Topic No. 6.** (Continued from 1939). Longitudinal cracking of flues in service.
Topic No. 8. Tender-cistern maintenance practices.

Evening Session

7:30 o'clock Motion pictures. Joint showing by the co-ordinated associations.

Friday, October 25

Morning Session

9:30 o'clock **Topic No. 4.** (Continued from 1939). Chemical treatment of boiler feedwater.
Topic No. 7. Causes and control of cinder cutting.

Afternoon Session

1:30 o'clock Report of the Executive Board.
Report of the Committee on Law.
Election of officers.

*Beginning Monday, October 21, 5:00 p. m. to 6:00 p. m. and each day following, starting at 8:45 a. m.

Locomotive Maintenance Officers' Association

Hotel Sherman, Chicago

Tuesday, October 22

Morning Session

8:00 to 10:00 o'clock Registration.

10:00 o'clock
President's opening address and report.
Secretary-Treasurer's report.
Introduction of members present.
Appointment of Nominating Committee.

Afternoon Session

2:00 o'clock What Members of the L.M.O.A. Can Do to Improve the Service on All Railroads—Address by C. B. Hitch, superintendent of motive power, Chesapeake & Ohio.

Wednesday, October 23

Morning Session

9:30 o'clock The Design, Operation and Maintenance of Diesel Electric Locomotives, by H. V. Gill, supervisor of Diesel engines, Santa Fe System.

11:00 o'clock Future Locomotive Air Brake Maintenance, by J. P. Stewart, general supervisor air brakes, Missouri Pacific Lines.

Afternoon Session

2:00 o'clock Use of Modern Machinery and Tools in Locomotive Repairs—Address by D. J. Sheehan, superintendent motive power, Chicago & Eastern Illinois.

Thursday, October 24

Morning Session

9:30 o'clock Roundhouse Problems of the Present Day—Address by H. E. Hinds, assistant mechanical engineer, Chicago, Burlington & Quincy.
Election of Officers.

Afternoon Session

12:30 o'clock Luncheon in honor of Advisory Board.
Speaker: John M. Hall, director of Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C. Subject: The Responsibility of the Locomotive Maintenance Officer and the Federal Inspector.
Remarks by Advisory Board Members:
O. A. Garber, chief mechanical officer, Missouri Pacific.
D. S. Ellis, chief mechanical officer, Chesapeake & Ohio.
J. Roberts, chief of motive power and car equipment, Canadian National.

Evening Session

7:30 o'clock Showing of educational motion pictures by the co-ordinated associations.

Friday, October 25

Morning Session

9:30 o'clock Maintenance of Locomotives on Long Runs, by Lee Robinson, superintendent of equipment, Illinois Central System.

Afternoon Session

2:00 o'clock
Secretary-Treasurer's report of convention.
Installation of new president and officers.
Outline for 1941.

Railway Fuel and Traveling Engineers' Association

Hotel Sherman, Chicago

Tuesday, October 22

Morning Session

10:00 o'clock Opening ceremonies, including address by Col. Robert S. Henry, assistant to president, Association of American Railroads.

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11:15 o'clock President's address.

11:30 o'clock Appointment of special committees.

11:35 o'clock Proportions of Steam Generated on Locomotive Boilers Used for Various Purposes, by E. E. Chapman, mechanical assistant, Atchison, Topeka & Santa Fe.

Afternoon Session

2:00 o'clock Locomotive Firing Practice—Oil, by Roy W. Hunt, fuel supervisor, Atchison, Topeka & Santa Fe.
Locomotive Firing Practice—Coal, by W. C. Shove, general road foreman of engines, New York, New Haven & Hartford.

Wednesday, October 23—Mechanical Day

Morning Session

9:00 o'clock New Locomotive Economy Devices, by A. G. Hoppe, assistant mechanical engineer, Chicago, Milwaukee, St. Paul & Pacific.

10:00 o'clock Address by D. S. Ellis, chief mechanical officer, Chesapeake & Ohio.

10:45 o'clock Utilization of motive power, by A. A. Raymond, superintendent fuel and locomotive performance, New York Central.

12:00 o'clock Turbine and Condensing Locomotives, by L. P. Michael, chief mechanical engineer, Chicago & North Western.

Afternoon Session

2:00 o'clock Report on New York Central Tests at Selkirk, by W. F. Collins, engineer of tests, New York Central.

Thursday, October 24—Air Brake Day

Morning Session

9:00 o'clock Air Brakes, by J. A. Burke, supervisor air brakes, Atchison, Topeka & Santa Fe.
(A) Braking of freight trains of 100 or more cars.
(B) Description and operation of braking with HSC passenger brake equipment.

Afternoon Session

2:00 o'clock Address on The Road Foreman and the Diesel Locomotive.

3:00 o'clock Stationary Boiler Plants—Coal Fired, by E. G. Sanders, fuel conservation engineer, Atchison, Topeka & Santa Fe.

Friday, October 25—Fuel Day

Morning Session

9:00 o'clock Who Uses and Wastes the Most Fuel, by J. G. Crawford, fuel engineer, Chicago, Burlington & Quincy.

9:40 o'clock Fuel Economy from the Viewpoint of the Chief Dispatcher, by T. O. Weeks, Missouri Pacific.

10:10 o'clock Fuel Records and Statistics, by E. E. Ramey, fuel engineer, Baltimore & Ohio.

10:40 o'clock Coal Preparation, by S. A. Dickson, fuel supervisor, Alton.
Coal Film.
Elections.
Secretary-Treasurer's report.
Special Committee Reports—Subjects.

Allied Railway Supply Association

Hotel Sherman, Chicago

THE 90 railway supply manufacturing companies listed below are those which up to August 24 had contracted for space at the Exhibit of the Allied Railway Supply Association which will be held at the Hotel Sherman, Chicago, October 22 to 25, 1940. This Exhibit will be in conjunction with the four-day meetings of the Car Department Officers' Association, Locomotive Maintenance Officers' Association, Master Boiler Makers' Association and the Railway Fuel and Traveling Engineers' Association. The total of 90 companies, already represented, compares with the final total of 101 companies in October 1937, when the previous Exhibit was held. Many types of railway mechanical devices will be shown and it will be a valuable feature of the co-ordinated mechanical associations meetings

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Air Reduction Sales Company, New York
Ajax Hand Brake Company, Chicago
American Arch Company, Inc., New York
American Locomotive Company, New York
Apex Tool & Cutter Company, Inc., The, Shelton, Conn.
Arrow Tools, Inc., Chicago
Ashton Valve Company, The, Boston (Cambridge), Mass.
Baldwin Locomotive Works, The, Philadelphia, Pa.
Barco Manufacturing Company, Chicago
Beaver Pipe Tools, Inc., Warren, Ohio
Berkley Machine Works & Foundry Co., Inc., Norfolk, Va.
Buckeye Steel Castings Co., The, Columbus, Ohio
Byers Company, A. M., Pittsburgh, Pa.
Collins & Aikman Corporation, New York
Carey Company, The, Jersey City, N. J.
Crane Company, Chicago
The Dampney Company of America, Boston, Mass.
Dearborn Chemical Company, Chicago
Detroit Lubricator Company, Detroit, Mich.
Duff-Norton Manufacturing Company, The, Pittsburgh, Pa.
De-Wel Steel Products Company, Chicago
Edna Brass Manufacturing Company, The, Cincinnati, Ohio
Ewald Iron Company, Louisville, Ky.
Flannery Bolt Company, Bridgeville, Pa.
Franklin Railway Supply Co., Inc., New York
Gilg, Henry F., Pittsburgh, Pa.
Graham-White Sander Corporation, Roanoke, Va.
Griffin Wheel Company, Chicago
Grip Nut Company, Chicago
Hanna Stoker Company, The, Cincinnati, Ohio
Holland Company, Chicago
Hulson Grate Corporation, Keokuk, Iowa
Hunt-Spiller Manufacturing Corporation, South Boston, Mass.
Huron Manufacturing Company, Detroit, Mich.
International Correspondence Schools, Scranton, Pa.
Johns-Manville Sales Corporation, New York
Lehon Company, The, Chicago
Lewis Bolt & Nut Co., Minneapolis, Minn.
Lima Locomotive Works, Inc., Lima, Ohio
Locomotive Firebox Company, Chicago
Lunkenheimer Company, The, Cincinnati, Ohio
MacLean-Fogg Lock Nut Company, Chicago
Mall Tool Company, Chicago
Miner, Inc., W. H., Chicago
Monarch Packing & Supply Co., Chicago
Morton Manufacturing Company, Chicago
Murdock Manufacturing & Supply Co., Cincinnati, Ohio
Nathan Manufacturing Company, New York
National Aluminate Corporation, Chicago
National Malleable & Steel Castings Co., Cleveland, Ohio
Cakite Products, Inc., New York
Ohio Injector Company of Illinois, The, Chicago
Okadee Company, Chicago
O'Malley Valve Company, Edward, Chicago
Oxweld Railroad Service Company, The, Chicago
Paxton-Mitchell Company, Omaha, Neb.
Penn Iron & Steel Company, Creighton, Pa.
Pilliod Company, New York
Pocket List of Railroad Officials, The, New York
Portable Equipment Company, Chicago
Prime Manufacturing Company, The, Milwaukee, Wis.
Pyle-National Company, The, Chicago
O & C Company, New York
Railway Purchases and Stores, Chicago
Ryerson, & Son, Inc., Joseph T., Chicago
Sellers, Wm. & Co., Inc., Philadelphia, Pa.
Simmons-Boardman Publishing Corporation, New York
Sinkler, Inc., Joseph Inc., Chicago
Spring Packing Corporation, Chicago
Standard Brake Shoe & Foundry Company, Chicago
Standard Car Sales, Inc., Chicago
Standard Car Truck Company, Chicago
Standard Stoker Co., Inc., The, New York
Superheater Company, The, New York
Superior Hand Brake Company, Chicago
Superior Railway Products Corporation, Pittsburgh, Pa.
Swanson Company, The, Chicago
Talmage Manufacturing Co., The, Cleveland, Ohio
Timken Roller Bearing Company, The, Canton, Ohio
T-Z Railway Equipment Company, Chicago
Union Asbestos & Rubber Co., Chicago
United States Metallic Packing Company, Philadelphia, Pa.
Unit Truck Corporation, Jersey City, N. J.
Valve Pilot Corporation, New York
Vapor Car Heating Company, Inc., Chicago
Viloco Railway Equipment Company, Chicago
Westinghouse Air Brake Company, Wilmerding, Pa.
Wilson Engineering Corporation, Chicago
Wine Railway Appliance Company, The, Toledo, Ohio
Worthington Pump & Machinery Corp., Harrison, N. J.

EDITORIALS

Half-Century of Achievement

The fiftieth birthday of the New York Air Brake Company, on July 1, 1940, is recorded in a brochure issued by that company which recalls, in illustration and text, a number of interesting events in the history of American air-brake development. Many of the younger generation of railroad men are probably unaware that 64 years ago the predecessor of the present company was organized to exploit the development of a competitor of the air brake. The Eames vacuum brake was a successful device. Although rapidly superseded in America following the successful demonstration of the air brake of George Westinghouse in the famous Burlington Brake Trials of 1887, the vacuum brake is still in use in other countries, and a part of the current business of the present company is supplying vacuum brakes to certain foreign railroads.

During the last World War, like so many other railway equipment and supply manufacturers, the New York Air Brake Company participated in the business of manufacturing munitions for the Allied governments. The brochure significantly points out that having done so, the company was ready to assist the government of the United States when it entered the European conflict.

One of the great difficulties our national government is facing today, that is, the necessity of expanding plant and personnel for the purpose of producing large outputs of non-commercial goods for a period of uncertain but relatively short duration, was taken care of by the process of business negotiation between our industries and certain foreign governments in the first World War. Something of the proportions of the problem thus solved in the first World War may be gained by this company's experience, which expanded a "normal modern complement" of 1,500 employees to a maximum of 4,500 during the war years.

The program of training required to effect such expansions in personnel cannot be carried out in a day, even though the need is for specialists rather than journeymen mechanics. Nor can the investment in plant and equipment expansion required to provide the tools for the expanded forces of workers in industry be properly considered as a burden on peace-time activities or as the cost of peace-time defense; in the present emergency proportions it can properly be considered only as a part of the price of war, even though we are not now and may not be in the present World War.

The simple statement of the New York Air Brake Company's part in the manufacture of munitions during the first World War, suggests strongly that the efforts of our isolationists to keep us from all contact with the present World War have succeeded principally in greatly complicating our problems, now that we have become aware, as a nation, that our safety can be assured only by the force of arms.

Treated Wood For Car Lumber

Treated wood has been used for car lumber to some extent on American railroads for many years, but it may well be doubted if lumber, treated by any of the several recognized methods now available to prolong its effective service life, is being incorporated in car construction as extensively as it should be, based on purely economic considerations. The increased use of treated car lumber, including its application to a considerable number of new cars built during the past year, does, however, indicate a growing appreciation of the potential advantages of this material in reducing car maintenance costs.

Some interesting information regarding the use of treated car lumber is included in a recent committee report to the American Wood Preservers' Association, which points out that the St. Louis-San Francisco, for example, uses annually substantial quantities of pressure-treated lumber for the decks of open-type cars, wood members of stock cars and siding for coal cars. In this case, the coal car decks and sides are creosoted and other members salt-treated. The Central of Georgia uses a considerable amount of creosoted wood for coal car decks and for all wood parts of stock cars, including running boards. The Louisville & Nashville is reported to have adopted a standard list of car members to be treated for use in stock, gondola and flat cars. The Santa Fe has standardized on creosoted decking and nailing stringers for flat cars, lumber for these purposes being cut to size before treatment.

In general, there are three factors which limit to a certain extent the wide adaptation of treated lumber for use in railway car equipment; namely, the cost of the treatment, physical characteristics of the individual treatments some of which may be objectionable for certain purposes, and the fact that, for best results, the lumber needs to be preframed before treatment. This involves rather drastic standardization of lumber sizes and also introduces some complications into the problem of repairs and replacements at other than central repair shops.

One of the tables included in the report referred to

shows, for example, a total of 424 pieces of lumber in a single stock car, varying in size from 38½-ft. side sills to 3-in. by 3¾-in. by 4¼-in. ladder cripples, the largest number of individual pieces of a given size being 180 $1\frac{5}{16}$-in. by 5¼-in. by 5-ft. roofing boards. Car lumber parts which are widely used can be pre-cut, treated and made generally available at system repair points, but it would hardly be feasible to have all of the 30 different items in stock, some of which probably would seldom if ever be used. Moreover, even freight cars of the same series often vary slightly in certain detail dimensions, so that preframed lumber, while made to standard dimensions, might not fit exactly when being applied for replacement purposes. This would mean cutting the lumber subsequent to treatment, thus reducing to some extent the protection afforded by the preservative treatment.

On one railroad that now uses treated flooring, stringer and furrings for flat cars, specified creosote treatment by the Rueping process is given to especially-selected lumber, milled to dimensions before treatment. When renewing the decking on these cars, a ¼-in. air space is left between adjoining planks to facilitate drainage, cement-coated wire nails and bolts being used to secure the lumber properly in place. Before the treated lumber is applied, the steel is thoroughly cleaned and painted in accordance with recognized practice.

To summarize, treated lumber has been successfully used for many car parts, and the greatest economy is secured when it replaces lumber which fails principally as a direct result of decay, or which becomes weakened sufficiently by partial decay to lower its inherent resistance to mechanical shock. In general, the various car parts best adapted to be made of treated lumber include all wood members of stock cars; composite gondola car sides, decks and nailing stringers; flat car decks and nailing stringers. Experience clearly indicates that, with due regard to the limitations of the various processes, the treatment of wood for car lumber is definitely advantageous and can be profitably followed to an increasing extent in the construction of railway equipment.

Evidence of a Change of Mind

For some time in the past the railroads of the country have been rather backward in matter of expenditures for the modernization of shops and enginehouses and have justified such a course on the ground that limited earnings have made it desirable to get the most out of shop equipment that in many cases has outlived its usefulness. The demand for greater accuracy in machine work and the proved ability of modern machine tools and shop equipment to pay for itself in a surprisingly short time have evidently convinced a number of mechanical officers that it is well worth while to put into effect a program of shop equipment replacement. Reports from various sources indicate decided activity in shop equipment buying.

A Cost Study Worth Continuing

Since 1925 the railroads of the United States have invested over 60 millions of dollars in Diesel powered locomotives and rail cars, and the question concerning the cost of operation of this type of equipment is one of vital concern to all who are responsible for its use.

The introduction of Diesel motive power in the railroad field was first justified, by its proponents, on the basis that it would provide a more economical form of power than steam, and as the installations increased in number in the succeeding years it became evident that there was considerable merit to this claim. It also became evident that, when comparisons were made, Diesel and steam costs had to be considered from the standpoint of operating costs, on the one hand, and fixed charges, on the other.

The higher initial cost of Diesel power might conceivably offset the advantages of lower operating costs unless the facility was used in a class of service where its high availability and high utilization factor would result in a low "per-hour" or "per-mile" cost. In this respect the problem of Diesel power in rail transportation is not in any sense different than that of steam or electric motive power—it is, after all, a problem in which the principal consideration is one of economics. In the light of that consideration it would seem that the development of accurate cost statistics with respect to the use of Diesel power should be a task of major importance; one of exceptional value not only to the roads that have already installed that type of power but also to those that may have such installations in contemplation.

In 1932 the Mechanical Division of the Association of American Railroads, through the activities of a sub-committee of the Locomotive Construction Committee prepared a study of Diesel operating costs. The fact that there were those who took exception to some of the figures embodied in that report did not in the least detract from the value of the work of the sub-committee. Its report presented facts concerning Diesel costs as they existed at that time. The report, under the circumstances provided a valuable basis for comparison with future similar studies.

In 1939 a similar A. A. R. Mechanical Division sub-committee prepared a Diesel cost report covering a six-month period of operation of 600-hp. switching locomotives. In a 1940 report to the Division it expanded the scope of its report to include a full 12-month period of both 600- and 900-hp. switchers. Thus, in a period of 15 years of operation of Diesel motive power the co-ordinated cost studies on this type of railroad

motive power operation are embraced in rather limited statistical data. The primary purpose of further discussion of this subject is to emphasize again the need for more complete data.

In an editorial which appeared in the July issue of *Railway Mechanical Engineer,* page 288, comment was made on the work of the sub-committee with respect to its 1940 report. That discussion was intended to convey an expression of opinion to the effect that the data already developed by the sub-committee were of definite value to the industry but that in spite of the fact that an excellent start had been made the required data are not by any means complete. In that discussion comment was made on the recommendation of the sub-committee to suspend, temporarily, its activities on the ground that sufficient information is available to justify such a course.

It is to such a recommendation that exception is taken on the basis that a break in the continuity of the cost data will adversely affect the value of future records. This exception is taken with full recognition of the fact that many conditions surrounding the operation of Diesel motive power at the present time may be such as to preclude the possibility of developing the kind of cost data that may be available when the time has arrived that Diesel operation has become more of a routine matter.

The previous editorial comment did not offer any suggestion as to the agency best qualified to make future studies of the cost of railroad Diesel motive power operation. It did, however, take exception to the previously-mentioned sub-committee recommendation and point to the interest of the A. S. M. E. in the subject as evidence of a growing, rather than a declining interest in such cost studies.

On the Reader's Page of this issue Lawford H. Fry, chairman of the Railroad Division of the A. S. M. E., has placed the position of that group on record. Mr. Fry questions the value of immediately continuing the collection of cost statistics and suggests that the A. A. R. Mechanical Division is the proper agency to do the job when the time comes. With this latter suggestion no reasonable exception can be taken and in view of the widespread interest in the subject it is hoped that the Mechanical Division will see its way clear to perpetuate the record already compiled. The important thing is to have the job done.

New Books

WHO'S WHO IN RAILROADING IN NORTH AMERICA. *716 pages. 8¾ in. by 5¾ in. Bound in cloth. Published by the Simmons-Boardman Publishing Corporation, New York. Price $7.50.*

The 1940 edition of "Who's Who in Railroading" is off the presses. Containing 5,300 biographical sketches of leaders in the field, as compared with some 3,800 contained in the previous edition, the new book brings up to date the hierarchy of the railroad transportation world after a ten-year interval. When the 1930 edition was brought out it was the intention to publish revised editions at intervals of about three years, but the economic depression made such a program impossible. Hence this new edition "takes up the slack" after a decade of manifold changes in the railroad business and its personnel.

The 1940 edition further extends the policy first followed in its predecessor of broadening coverage to leaders among the equipment and supply companies, railroad labor leaders, state and federal regulatory authorities, transportation economists, specialists in railway finance, educators, I. C. C. practitioners, consultants, authors, editors and other experts. Naturally, the inclusion of leaders outside of railroad personnel proper brought with it a difficult task of selection requiring a wide knowledge of the field. To accomplish this and capitalize on the experience of a large group of observers, the combined staffs of the five Simmons-Boardman railroad periodicals were consulted for recommendations and in the case of highly specialized groups outside authorities were asked for selections.

The 1940 edition also carries on the policy initiated in 1930 of "personalizing" the biographical sketches by the addition of family data, social, political and religious affiliations, etc., to the more formal career statements.

"Who's Who in Railroading" is a lineal descendant of the well-known "Biographical Directory of Railway Officials of America," the first edition of which appeared in 1885. Subsequent editions were published in 1887, 1893, 1896, 1901, 1906, 1913 and 1922.

SMOKE PREVENTION. *Manual of Ordinances and requirements in the interest of reduced air pollution, smoke elimination and fuel economy. 160 pages, 5 in. by 8 in., bound in paper. Published by the Smoke Prevention Association of America, Inc., 139 N. Clark street, Chicago. Price, 60 cents.*

This well-illustrated book contains, in addition to a report of the association's annual meeting, May 21-24, 1940, at St. Louis, Mo., a large amount of specific data describing methods of measuring air pollution, promoting fuel economy and developing a constructive approach to all phases of the problem of smoke elimination.

The book is of unusual interest to railway officers because of the considerable number of papers on specific railroad subjects that were presented at the May meeting as follows: Methods Employed by the Railroads in Eliminating Smoke, by H. J. Riddle, division road foreman of engines, Pennsylvania, St. Louis, Mo.; Locomotive Smoke Abatement, by William G. Christy, smoke abatement engineer, Hudson County, N. J.; How the Railroads Are Attacking the Smoke Problem, by R. C. White, assistant general manager, Missouri Pacific, St. Louis, Mo., and Future Outlook for the Prevention of Smoke from Railroad Locomotives, by D. C. Buell, Railway Educational Bureau, Omaha, Neb.

THE READER'S PAGE

The Question of Diesel Costs

To the Editor:

The editorial on page 289 of your July issue on Diesel locomotive operation calls attention to the excellent report of the Locomotive Construction Committee of the A. A. R. Mechanical Division. As chairman of the Railroad Division of the American Society of Mechanical Engineers, may I offer a word of clarification regarding the last paragraph, which suggests that the A. S. M. E. should participate in further study of the costs of Diesel locomotive operation.

The Oil and Gas Power Division of the A. S. M. E. has been studying for some years the cost of operation of stationary Diesel engines and, with the growing use of the Diesel locomotive, has felt that study might be extended to this field. Preliminary consideration shows that the A. A. R. Locomotive Construction Committee has covered the situation very completely, and the report drafted by the A. S. M. E. committee uses the very complete data of the A. A. R. report and will make this excellent work available to a wider circle of engineers.

The application of Diesel power to locomotive service is in a state of flux and development; and before further cost statistics are collected, time should be allowed for clarification. This is a matter which should be properly left in the competent hands of the appropriate A. A. R. committees.

The Railroad Division of the A. S. M. E. hopes that cooperation with the A. A. R. Mechanical Division on this and other subjects may be possible in the future.

Lawford H. Fry,
Chairman, Railroad Division,
American Society of Mechanical Engineers.

Damaging Effects of Water in the Cylinders

To the Editor:

After reading the published accounts and studying the photographs of the deplorable wreck on the New York Central at Little Falls, New York, I awaited the official report as to the cause.

During my years of experience as a machinist and mechanical officer in railroad service, I have investigated and reviewed many accidents to locomotives and trains. I have seen the damaged locomotives after two of them had met, head-on, at approximately 50 m. p. h.; also when they met at an angle. I have seen them after a boiler explosion where the boiler was torn from its fastenings and hurled into the field beyond the right-of-way. I cannot recall a case where the destruction was as complete as indicated by the photographs of the N. Y. C. wreck. Heavy locomotive frames were broken by tension, and cylinders and saddle were torn from the boiler, indicating a force greater and different from what we would expect when a heavy train traveling 60 m. p. h. would strike a stationary object.

What Could Have Caused This Accident?

Years ago, as a machinist on the Burlington, I was detailed on experimental work at one of its important terminals. We found piston-rod keys would shear in the crossheads, and that piston rods would be driven into the crosshead so tight we had to design special tools to separate them. Cylinder packing was broken; cylinder heads broken and sections pulled out of the cylinders. Strengthening the weak parts transferred the breakage elsewhere.

Water in the cylinder was the cause. We started a campaign of supervision and instruction by the traveling engineers and traveling firemen. This did not effect a cure, due to that inborn fear of low water on the crown sheet, but it did reduce the accidents.

Water is incompressible. Now, picture water between the piston and front cylinder head on an engine with rings and parts proof against leakage. The locomotive with the momentum of a heavy train may be traveling at 60 m. p. h., drivers 300 r. p. m., crosshead pin traveling an average speed of 1,500 ft. per min.

Assume a volume of water completely fills the space between the piston and front cylinder head when the piston is 8 in., 6 in. or 4 in. from its extreme forward travel. At this point the crank pin is approaching the dead center where the power applied is tremendous. One familiar with the laws of physics can well understand how a force built up under this condition can tear a locomotive frame in two, rip the cylinders and saddle from the boiler, thus releasing water and steam and apparently indicating a boiler explosion. One may say the main rod would buckle. Remember this happens in a minute fraction of a second—"velocity." It is velocity that enables a tallow candle to penetrate a wooden plank. It is velocity that enables a straw to penetrate the trunk of trees during heavy windstorms.

Recently, a new locomotive out of the shop, in service, stripped itself completely. Crank pins were partly pulled from wheels, wheels were loosed on axles, rods were peculiarly bent—a clear case of water, though the investigators gave a different decision.

Read the 1940 Mechanical Division Committee report on checks, cracks and breakages in crank pins, axles, main and piston rods. We experienced these same troubles. I could include scored cylinders, broken valve and cylinder packing, and many others. This trouble has existed from the advent of the steam engine. Its effects become more disastrous as speed increases.

Enginemen, in the interest of self-preservation and safety first, abhor low water. The tendency is to carry water above the safe maximum high. Automatic feeds sometimes fail to maintain this desired level. When the superheater was adopted, it was thought this trouble would disappear but it was found the enginemen in their desire to avoid scorched crown sheets carried the water at a higher level, necessitating further individual instruction.

Eternal vigilance and constant instruction by properly trained, practical men is the answer. High water level in the boiler always leaves its mark. Unless it is corrected, trouble is sure to follow.

M. D. Franey

No Place for Complacency

To the Editor:

Your editorial on boiler explosions in the February *Railway Mechanical Engineer* is a timely presentation of a subject only too often passed over in obvious haste. The final sentence is especially worthy of careful attention from supervisory officers.

Your readers probably remember the disastrous explosion of a Northern Pacific Class Z-6 articulated locomotive in July, 1938.* I sent a copy of the official I. C. C. report on this explosion to an old friend who was for many years director of locomotive design and construction at one of the largest plants in Germany. A portion of his comments, freely translated, may be of interest:

"In Germany, we have at the most *one* explosion every three or four years. But, when I read this report, I do not wonder at the many explosions in America. Here, the lowest permissible water level is 100 mm. ($3\frac{15}{16}$ in.) as against 3 in. in the U. S. A., but the latter figure is only nominal since the report shows measurements of $2\frac{3}{8}$ in. This is careless construction. Staybolt spacing here is usually not over 85 mm. ($3\frac{3}{8}$ in.) as compared with 4 in. in the U. S. A.

"Three men on the locomotive did not hear the alarm whistle! Or did it perhaps not function? In all of Europe we have not one alarm whistle . . . For a full two weeks defective working of the pump was complained of almost daily and just as often the prescribed repairs were vouched for. And what all they did find in the water tank! At the same time the water glasses were apparently all in order. Such unbelievable carelessness on the part of the personnel! At any rate, the report casts a deplorable light on American locomotive construction and operation."

There are a little less than half as many steam locomotives in Germany as in the United States, a fact which accounts for some part of the difference in frequency of boiler explosions. But much of the difference must also be credited to the rigid system of inspection and discipline instituted by the security police, under whose jurisdiction steam boilers were placed as early as 1850. This extreme care in inspecting, testing and operating boilers has been continued by the railway officers until the present day. It is doubtful, however, if the discipline imposed on the shop and road forces would be practical in America.

The closer staybolt spacing in German boilers is no doubt due to the use of copper for inner firebox sheets. They have never been able to use steel with conspicuous success. Some thought might profitably be applied to a study of the lowest permissible water level. In the huge boilers of today, with their tremendous evaporative capacity, 3 in. is little more than a film of water above the crown sheet. Another inch might well be added, if only as a precaution against errors in construction which are sometimes found in boilers emanating from shops of the highest reputation.

It is pleasing to note your rejection of the complacent view that four or five explosions per year might be considered an irreducible minimum. Those who hold that opinion (and there are a few) will sooner or later arrive at the state of mind which E. L. Ahrons once described as characteristic of the early native officers in Egypt. When a boiler blew up in those day, the railwaymen were told: "Never mind. Get another engine. Allah wished that one to come to grief, and lo!; see what has happened to it."

Wm. T. Hoecker.

*An editorial commenting on this appeared in the November, 1938, *Railway Mechanical Engineer*, page 453.

Determining Boiler Capacity

To the Editor:

We notice a rather frequently asked question regarding boiler capacities, etc., on page 330 of your August, 1940. issue under the title "Locomotive Boiler Questions and Answers." While the answer given is quite comprehensive, we feel that some of the information is incorrect or considered obsolete, particularly for modern power.

Boiler evaporation is, as stated, based on the flue and tube surface area and the direct or radiant surface area of the firebox and combustion chamber. However, we now use the total tube and flue heating surface and multiply this by an evaporation factor varying from 13 lb. for a 10-ft. length to 8.2 lb. for a 24-ft. length, and while we are still using a 55-lb. rate for the furnace in general, we frequently use 90 lb. for very large power. Tests have shown many times and numerous articles have frequently pointed out the excess of actual power developed over the theoretical, hence the Locomotive Institute is seriously considering the 80-lb. rate, on the basis of which tests are closely approximated.

Consideration must be given to locomotive proportions, such as brick arches, combustion chambers, syphons, and the capability of the grate to supply the necessary heat. After all, the grate is the basic factor and must always be checked. Feedwater heaters must also be considered, as they increase evaporation by eight per cent or better.

On steam switchers, evaporation is always based on the grate since the intense combustion developed in road locomotives produces high rates of evaporation which are never attained on switchers because of their lack of design features and the relatively slow speeds at which they operate.

As to the injector capacity on large locomotives, it must be borne in mind that one injector or the feedwater heater may fail, and the spare injector must assume the full burden. Therefore, we deem it advisable to provide injectors, each of which can supply an adequate quantity of boiler feedwater.

Today, maximum horsepowers are developed at speeds far in excess of 1,000 ft. per min., and saturated locomotives in road service and even switchers are practically extinct. Modern locomotives are considered to develop maximum horsepower at piston speeds of about 1,500 ft. per min. In fact, in actual service this speed may approach 2,000 ft. per min.

The latest edition of our book, Locomotive Data, explains in considerable detail a generally accepted method for preliminary locomotive calculations.

Cole's ratios in their original form are generally conceded to be antiquated, and frequently, when certain forms of technical information are published, it is followed without the tempering effect of experience. Considerable difficulty is often encountered in convincing some calculators of the inadequacy of a method that may have been adopted from some publication and have them accept one along contemporary lines.

Edward J. Harley,
Assistant chief engineer,
Baldwin Locomotive Works.

Stenciled Advertising On Freight Equipment

In December, 1939, the Atchison, Topeka & Santa Fe decided to utilize the space on freight equipment, not taken up by the necessary reporting marks and A. A. R. data, for advertising the principal trains and service of the Santa Fe system, and a program of applying this material was begun, which, when finally completed, will embrace a total of 27,984 box, automobile and refrigerator cars.

Through a process of trial and elimination, it was decided to utilize only the equipment which presented smooth sides for this application, several attempts at placing this upon cars with exposed side posts and recessed side posts having resulted in unfavorable appearance.

From the standpoint of neatness and legibility, a method of application had to be found which would give, first, the details of the design of lettering used in the material; second, clean, sharp lines and edges; and third, relatively low cost per individual application through a fast time-saving and labor-saving process. It was decided to use stencils as the method most suitable to comply with all three requirements, and to use them with paint spray guns for applying the paint.

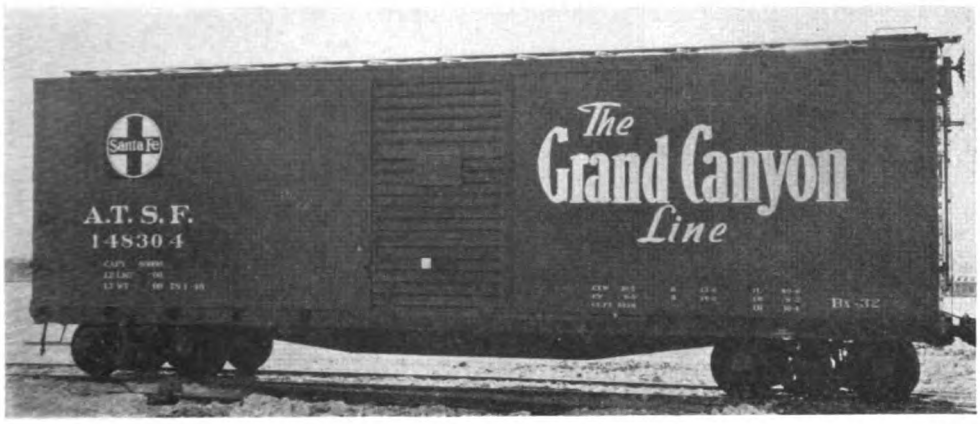
These stencils were first made from zinc sheets which were etched by acid in the conventional manner used for all stencils of this type. These designs were photostated at an exact size of one inch per foot scale in relation to the actual size selected for the space available on the sides of the equipment. These photostats were then carefully scaled up in every detail on a working drawing and blueprinted for the stencil cutters. The prints were then used by the stencil cutters to lay out each sign full size on paper patterns.

The signs selected by the Santa Fe are as follows: A skeleton map of the Santa Fe system showing the principal terminals and intermediate large cities and the words "Santa Fe All the Way" laid on the map as a background so that "Santa Fe" identifies the map instantly and the slogan "All the Way" interprets the significance of the map. This is placed on the right side of each car which receives the advertising material and is made in two sizes, 12 ft. 6 in. by 6 ft. for cars 40 ft. in length and 17 ft. by 7 ft. for cars 50 ft. in length.

For the left side of each car, there are five selected signs advertising the most famous trains and carrying the message to all of their respective special merits. These signs are: "The Grand Canyon Line," a slogan identified with the Santa Fe system for many years; "The Scout, for Economy Travel West," which describes the famous economy service of this train; "El Capitan, Coach Streamliner West," which is the only exclusive coach streamliner in service between Chicago and Los Angeles; "The Super Chief to California," which carries the story simply and effectively; and "The Chief, Famous Daily Streamliner, West," which completely describes the famous Chief, now in operation since 1926 and the only daily streamliner to California. These signs are also made in two sizes, 12 ft. 8 in. long by 6 ft. high for cars 40 ft. in length, and 15 ft. 6 in. by 7 ft. for cars 50 ft. in length.

The letters and design of these signs are both powerful and legible, due to the thick stems and well-proportioned width and height of each letter. Lower-case styles are used except for necessary capital letters, and in a few cases the words are in italic style for greater emphasis through variety of form. Visibility and legibility of the signs are therefore at a maximum.

Two colors of paint are used as follows: on all refrigerator cars which have orange yellow body paint, the signs are in black enamel, which gives a combination most easily read at a distance. The box and automobile cars which have red body paint have signs ap-



One of five selected signs now being placed on the left side of system-owned house cars to advertise famous Santa Fe scenic routes and special trains



Railroad insignia, skeleton map and slogan now being stenciled on the right side of Santa Fe box and refrigerator cars

plied in white mineral paint, which is a good combination for legibility and contrast.

The paper patterns when laid out full size are traced on zinc sheets covered with lead foil, and the foil is removed where the body of the letter is cut out. This surface is then etched out by immersing in acid. As the stencils are quite large, it was a long task to use this process, so a machine was purchased and at present the signs are cut directly from tracings on the zinc sheet, without the use of lead foil or etching, and the time and cost of each stencil was reduced as compared with the old method.

As the signs advertising trains are to be proportioned out equally over all the cars, it is seen that each of them will be used only one-fifth as much as the map stencil. Therefore, the signs advertising the trains are now made of No. 300 red stencil paper framed in popular wood and the "ties" in letters and the surface of the stencil stiffened by taut piano wires passing from one side of the frame to the other. The stencil is processed with linseed oil and two coats of clear lacquer, and the piano wires are held to the "ties" by Comet cement. This method of preparing a stencil has the advantage of lightness, and costs one-quarter as much as a zinc stencil.

The stencils are applied in a few minutes by the use of suitable brackets and hangers which place them in the proper location on the car and accurately, and in instant readiness for the spraying on of the paint.

This campaign of advertising the Santa Fe and its trains is being carried out with dispatch. The cars to be stenciled will include 2,000 40-ft. box cars and 200 50-ft. automobile cars being rebuilt at Topeka Shops, as well as 1,800 new box cars received from the Pullman-Standard Car Manufacturing Company and 450 refrigerator cars received from the General American Transportation Corporation.

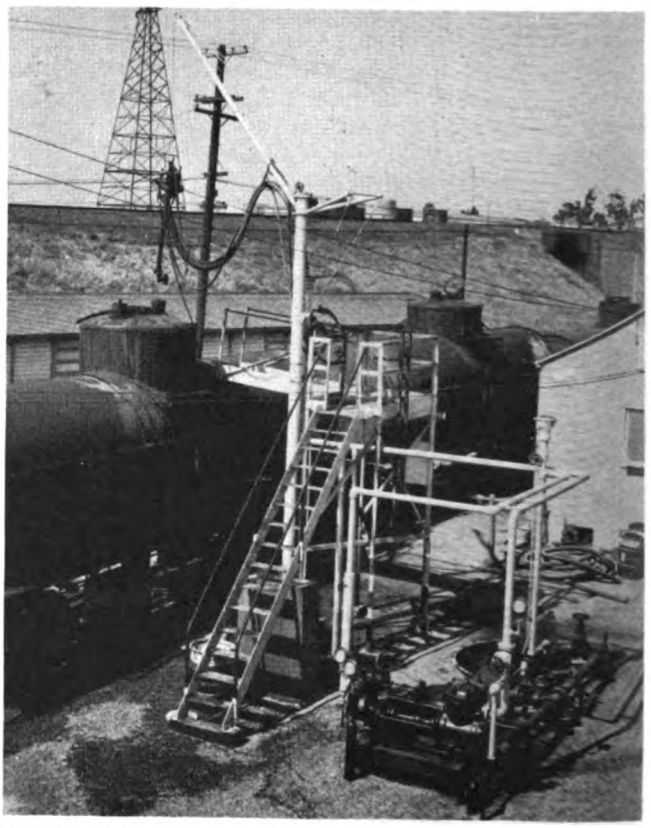
Unit Mechanically Cleans Tank-Car Interiors

By L. B. Johnson*

The railroads are becoming increasingly interested in new and modern cost-reducing equipment, particularly for use in departments where there is a substantial volume of identical units to be maintained or produced. An interesting development illustrating this is a new tank-car interior cleaner that in actual use has demonstrated its ability to speed up tank-car cleaning and reduce maintenance costs on this type of work by over 50 per cent. With the national defense program gaining speed and momentum and the likelihood of greater demands being placed on the railroads for transportation facilities, the significance of this contribution to increased efficiency and in speeding up maintenance in this one instance is quite apparent.

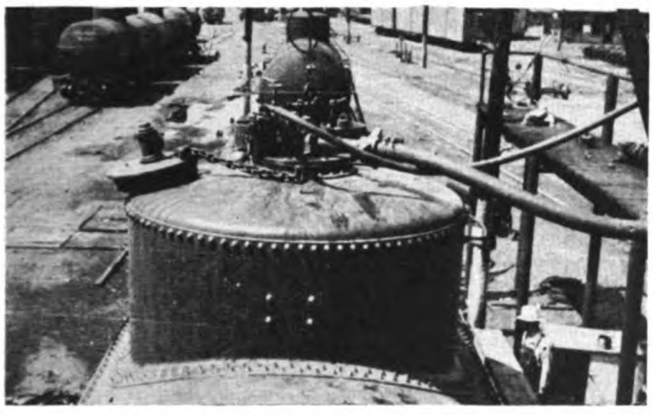
Executives in charge of rolling stock are familiar with the fact that cleaning the interior of tank-cars used for the transportation of crude, fuel, stove or various vegetable oils and similar liquid products has been considered both a disagreeable and an expensive job. In general, the procedure usually followed to clean the interior of a tank car that has carried heavy crude oil is, first, to steam out the car to "kill" any gases present and to make it safe for men to enter to scrub or scrape interior surfaces and to muck out heavy deposits. The time required for steaming usually varies according to the demand for cars. In many cases, cars are steamed overnight. In others, the period of preliminary steaming is shorter, but it is an operation in which considerable time is expended before workmen enter car and start the actual, physical cleaning. After steaming, one method followed is to scrape the sides where necessary, and then scrub with a solution of caustic soda or similar raw alkali. Sometimes hydro-carbon solvents, in addition, are employed to obtain the desired degree of cleanliness. After scraping and scrubbing operations, usual rinsing follows, but often when the job was presumably completed, inspection revealed that it was necessary to go over surfaces again due to oil spots and other deposits remaining in the seams of plates that men either failed to see or did not remove during the first cleaning operation.

There are four main objectives to be considered in connection with tank-car cleaning: (1) Interior surfaces of tank car must be thoroughly clean; (2) method used must do the work speedily; (3) cost should be low, and (4) the method employed should be safe. That a device is available which meets these four main requirements is an achievement of more than usual importance, and since it includes many original features in its design and operation, it has been granted U. S. Patent protection. The device or machine is known as the Oakite interior tank cleaning unit, Model 324. When used with the recommended Oakite material it is possible mechanically to clean an average tank car which has carried crude oil, without the necessity of a preliminary steaming operation, in from 1½ to 2 hr., depending on the condition of the tank. In other words, deposits are removed mechanically instead of manually. The actual time of cleaning by the unit ranges from 20



Auxiliary equipment includes crane for lifting unit, platform, duplex pump and piping for carrying cleaning solution

* Manager, service department, Oakite Products, Inc.



Oakite interior tank-car cleaning unit installed in the car dome

to 40 minutes. The remaining time is taken up by necessary rinsing operations with hot and cold water. Compared with manual method of cleaning, the results obtained are far superior.

This cleaning unit is an automatic, motor-operated machine, developed by the Oakite engineering staff. The unit is substantially constructed and designed so as to eliminate fire hazard from sparks. Its motor is air operated, requiring a pressure of 50 lb. per sq. in.

Sequence of Operations

The unit is hung from a light crane and counter-balanced with a weight so that it may be lowered with one hand, into the dome of a tank car. Air and solution hoses are permanently connected. The unit may be lowered and bolted to the dome of car by special clamps, which are regular equipment, by one man in less than two minutes. When installed, the revolving nozzles of the unit are located midway between the top and bottom surfaces of the tank car being cleaned. A cleaning solution is delivered to the unit at a pressure of 100 lb. per sq. in. by a 10-in. by 6-in. by 10-in. steam-operated duplex pump. The cleaning solution and hot water rinse previously referred to are taken from two 1,000-gal. tanks fitted with hinged covers and set flush with the ground. These tanks are heated with steam coils, the solution being piped through a steam-operated duplex pump to the cleaning unit, so that either solution may be used as required. The cold rinse is taken direct from the regular supply.

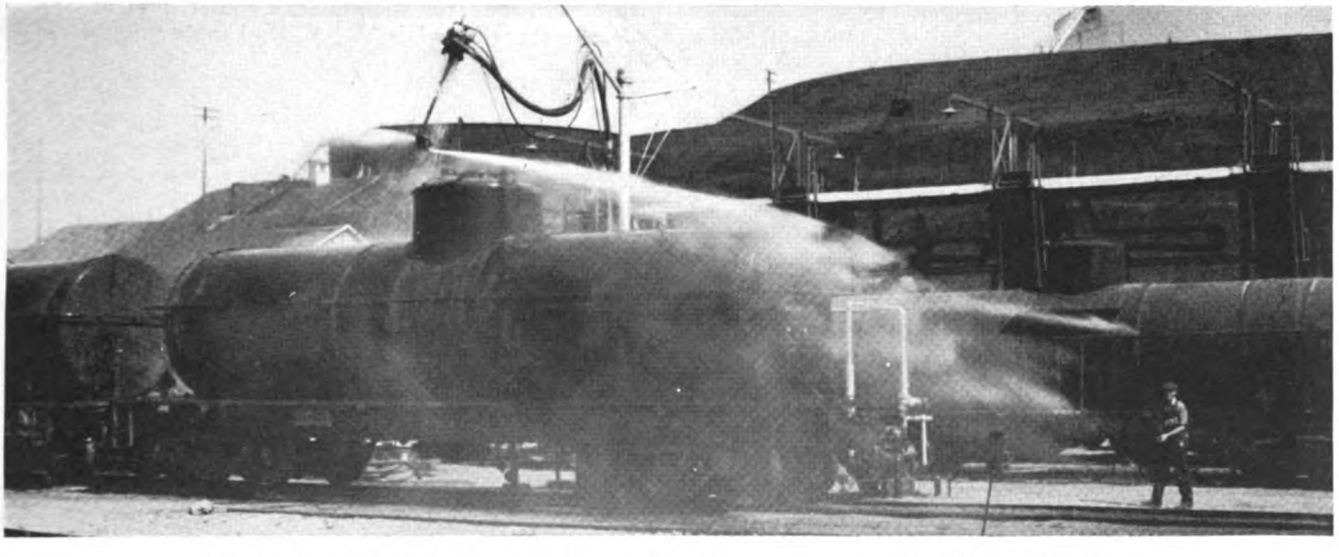
Entire Interior Surface Reached

The hot cleaning solution is delivered by the two nozzles which slowly revolve in two concentric circles starting with one nozzle pointing straight up and the other down. During the cleaning operation, the two high pressure streams from nozzles are delivered against every square inch of the interior surface of the tank car being cleaned. These high pressure streams of hot solution remove the most tenacious dried-on oils and deposits due to their knife-like cutting and cleaning action.

As the operation proceeds, the cleaning solution runs down the inside surfaces of the tank car where it falls or flows by gravity through the dump valve to a catch box made up of light-gage sheet steel. From there the solution in turn flows back through an underground pipe into the 1,000-gal. main tank. Thus the same cleaning solution is re-circulated and used over and over again. The hot rinse is re-used in the same way as the cleaning solution.

After the unit has been in operation for from 20 to 40 minutes, the latter period of time only being necessary where exceptionally dirty cars are to be cleaned, a hot and then cold water rinse follows. These rinsing operations are, as previously noted, performed by the same unit. After the hot and cold rinsing, the tank car will be found entirely free of any gas or oil odor. Where a car has not been cleaned for an unusually long period or where deposits are of an unusually heavy character, a small amount of inert matter may be found on the bottom at each end of the car, but this may be easily removed by one operator scraping and then flushing deposits out with a hand hose. The time required, where a condition like this may be found, will range from 20 to 30 minutes, but the total time for complete tank-car cleaning operation, based on actual experience, does not exceed two hours.

The cleaning of gasoline tank cars either for repairs, such as re-grinding valves, removing rust and scale, or for change-over to another type of liquid product, is accomplished with unusual speed and thoroughness when the Oakite Model 324 unit is used. Here again the necessity for preliminary steaming to get rid of volatile gasoline fumes and vapors is entirely eliminated. Moreover, the high pressure stream of Oakite cleaning solution from the two slowly revolving nozzles removes loose rust and scale so that any manual work, that may be required to complete scale and rust removal, is reduced to a minimum.



Powerful ejection of stream of boiling cleaning solution is shown by the distance and angle of the spray

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Responsibility for Unrepaired and Improperly Repaired Damage to Car

During November, 1938, St. Louis-San Francisco box car 127813 was derailed and damaged on the Missouri & Arkansas. At the request of the M. & A., the St. L.-S. F. shipped two door castings and two door-track castings to the M. & A., account handling-line defects, and were advised that the car would be repaired and returned to service by December 15, 1938. On January 1, 1939, this car was received empty by the owner at St. Louis, Mo., at which time it was noticed that the car had been extensively damaged, that all damage had not been repaired, and that some items had been improperly repaired. An inspection of the car was made at this point by the assistant chief interchange inspector who signed a joint inspection certificate showing the defects. A defect card was not issued as the owner's recourse for the defects was against the M. & A. who damaged the car and made certain repairs. The car was moved to the owner's shop at Springfield, Mo., where an additional joint inspection was made on February 2, 1939, a copy of which was furnished the M. & A. with a request for a defect card to cover the defect. On February 8, 1939, a representative of the M. & A. inspected the car at Springfield, Mo., and agreed to issue a defect card for some of the items. The M. & A. declined to issue a defect card on the balance of the items as it felt the defects were properly repaired.

In a decision rendered November 16, 1939, the Arbitration Committee stated: "It is agreed the car was damaged in a derailment, a Rule 32 condition. The joint evidence certificate dated February 2, 1939, indicates that some of the defects were not completely repaired and also there was associated Rule 32 unrepaired damage on the body and trucks that was caused at the same time. The M. & A. claim some of these unrepaired defects were old which is an admission that they were in existence when the car was in its shop, and no claim or evidence has been presented that damage occurred subsequent thereto. The M. & A. should, therefore, issue its defect card for the damage shown in the joint inspection certificate dated February 2, 1939, except for five items on which the car owner has waived defect-card protection."—*Case No. 1774, St. Louis-San Francisco versus Missouri and Arkansas.*

Cars Damaged or Destroyed by Fire

On May 27, 1937, CYCX cars 24410 and 27055 were badly damaged by fire on the Virginia Central team track at Fredericksburg, Va. CYCX car 27055 was fully carded by the Virginia Central for defects and sent to the Norfolk, Va., shops of the Pennsylvania-Conley Tank Line where complete repairs were made. A bill for these repairs was rendered against the Virginia Central and submitted for payment in August, 1937. This bill was never paid. CYCX 24410 was sent to the General American Transportation Corporation's shops at Sharon, Pa., carrying Virginia Central defect cards for items which only covered a part of the existing damage. On August 10, 1937, a joint inspection was made for items that were not carded and the Virginia Central was requested to furnish additional defect cards covering these items. The Virginia Central refused to furnish these cards and disclaimed all responsibility for the damage involved. The Virginia Central declined to join in presenting this case before the Arbitration Committee and the Pennsylvania-Conley Tank Line presented the above facts in Ex-Parte form for a ruling as to the responsibility for the damages.

In a decision rendered November 16, 1939, the Arbitration Committee stated: "The evidence submitted indicates that these cars were damaged by explosion and fire while in the possession of the Virginia Central. Therefore, the Virginia Central is responsible."—*Ex-Parte Case No. 1775, Pennsylvania-Conley Tank Line.*

Joint Evidence for Improper Size of Side Planks Not Sustained

The St. Louis-San Francisco applied side-plank splices to Seaboard Air Line gondolas 99604 and 96801 on October 24 and October 25, 1938, respectively, at Birmingham, Ala. Later, the S. A. L. obtained joint evidence, signed by the chief interchange inspector at Birmingham, on both these cars which showed that side planks 9¾ in. instead of 10 in. wide had been applied to both of these cars, and also that the stenciling on car 96801 had been partly omitted. The S. A. L. requested the St. L.-S. F. to furnish defect card in line with A. A. R. Rule 13. A defect card was furnished for the omitted stenciling but was declined on the variation in width of the side planks. The St. L.-S. F. contended that the A. A. R. Manual of Standard and Recommended Practice, Section A, Page M-907-33-10, Paragraph 35, provides that the standard rough dry widths of car lumber from 8 to 12 in. shall not be more than ⅜ in. less than the nominal widths and, therefore, as the width of the side-plank splices was ¼ in. under the nominal width or less than the variation permitted by A. A. R. Specifications, the application of such planks does not constitute wrong repairs. The S. A. L. contended that, as both cars were designed for the purpose of carrying sand and gravel, the application of side boards with a ⅜-in. permissible variation in the widths of these boards would defeat the purpose for which they were intended.

In a decision rendered November 16, 1939, the Arbitration Committee stated: "There are no A. A. R. Standard dimensions for side planks, but, in view of the tolerances permitted in A. A. R. Lumber Specification M-907 for rough and finished lumber of these dimensions, the contention of the St. L.-S. F. is sustained."—*Case No. 1776, St. Louis-San Francisco versus Seaboard Air Line.*

Air Brake Questions and Answers

D-22-A Passenger Control Valve (Continued)

596—*Q.—How should the piston and non-pressure head assembly be reconditioned?* A.—First, place it in a special fixture which will hold the release spring partially compressed and proceed as follows. Remove the piston rod sleeve protector, the protector ring retainer plate, the protector rings, the felt ring and its compression ring. Then remove the non-pressure head and the

release spring from the piston rod. Blow out all dirt of the non-pressure head and at the same time blow any loose dirt from the strainer. Remove and examine the strainer. If found to be in good condition, re-install it, otherwise substitute for one in good condition. Using a scraper and then the specified solvent, clean the protector ring recess in the non-pressure head, the protector rings and their retainers, the non-pressure head gasket face, and the piston and rod. If the piston is rough, smooth it with emery cloth. Using a file, break any sharp edges from the ends of the opening in the non-pressure head which guides the piston rod. Re-condition the piston rod felt ring by soaking it in a solvent to dissolve the grease and brush it to remove the surface dirt. If damaged or worn so that its spring cannot close it firmly on the rod, apply a new one after soaking it in oil. Examine the brass protector rings for wear and fit, replacing them if they do not close firmly on the rod. Examine the release spring. If rust spots are found, clean with emery cloth and coat with rust preventative.

597—*Q.—How should the piston and non-pressure head be re-assembled? A.*—After completely coating the rod with brake cylinder lubricant, place the piston and rod in the holding fixture. Then apply the spring and non-pressure head, using the locking mechanism of the fixture to hold the spring partially compressed. Place the felt ring around the piston rod in the bottom of the recess. The felt swab is held in contact with the piston rod by a circular spring wire around the outer diameter of the swab, using care to see that this spring is properly located. This may be easily accomplished by using a sleeve about 6 in. long, having an inside diameter which is a loose fit over the piston rod and an outside diameter slightly larger than the outside diameter of the felt swab. Another sleeve about 3½ in. long with an inside diameter which is a sliding fit over the long sleeve is used. The spring wire is placed over one end of the long sleeve and this end of the sleeve put over the piston rod and in contact with the felt swab. The shorter outer sleeve is then moved along the long sleeve so that the spring wire is forced off the long sleeve, this places the spring wire in its proper position around the felt swab to hold it in contact with the piston rod. Fill the protector recess about one-third full of brake cylinder lubricant. Place the metal retainer on top of the felt swab, then assemble the brass protection rings with their ends staggered. Completely fill the recess with brake cylinder lubricant, apply the retaining plate and securely lock the cap screws with lock washers.

598—*Q.—How should the packing cup be applied? A.*—It should be applied by starting the cup over one end of the piston and, while holding it in this position, work the cup into place. If the cup does not seat properly due to trapped air, the air can be removed by raising one side of the cup, using the wood tool and pushing the cup into place with the hands.

599—*Q.—If a pipe breaks off or a hose is ruptured leading to the truck brake cylinder, or brake rigging becomes defective on one truck, is it necessary to cut out the brake on that car? A.*—A cut-out cock is located in the brake cylinder pipe leading to each truck, which provides for cutting out the brake on one truck without affecting normal brake operation on the other truck.

600—*Q.—If necessary to cut out the brake on a car having control valve equipment, how is it accomplished? A.*—By closing the branch pipe cut-out cock, which is part of the combined cut-out cock and dirt collector, and holding the duplex release valve fully open until the reservoirs are drained.

601—*Q.—In the event of a "stuck brake" with the brake pipe fully charged, how may the brakes be released? A.*—By moving the handle of the duplex release valve part way to reduce the auxiliary reservoir only. When the brake starts to release, the release valve should be allowed to close in order to avoid waste of air.

602—*Q.—If the supply reservoir drain cock is open, how will the operation of the brake be effected? A.*—As the supply reservoirs are the source of brake cylinder air supply, the brake will not apply with the supply reservoirs uncharged.

603—*Q.—What is the purpose of the safety valve attached to the D-22-A control valve? A.*—To limit displacement reservoir pressure, and therefore brake cylinder pressure, during a service brake application.

604—*Q.—To what pressure does the safety valve limit displacement reservoir pressure? A.*—Between 60 and 63 lb.

605—*Q.—What is the purpose of the retaining valve? A.*—To retard the release of the brake cylinder pressure in order to provide the required time to recharge reservoirs when descending heavy grades.

* * *



Cleanliness is highly stressed at the Galesburg steel car shop of the C. B. & Q. where this tractor and side-dump trailer offer a convenient means of transporting refuse and dirt up the inclined runway for easy loading on the dirt car

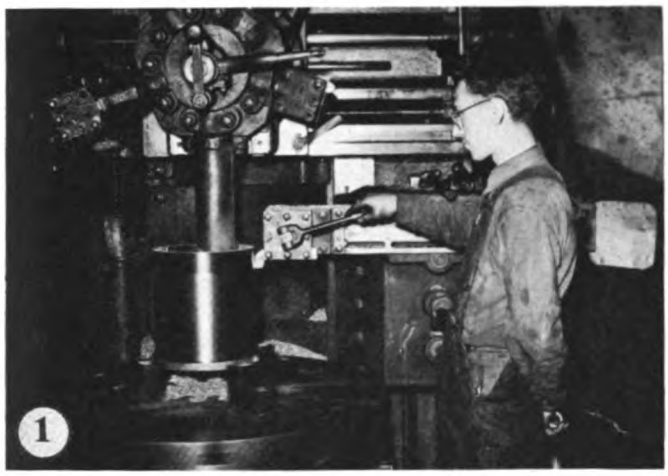
Performance of

Carboloy on Railroad Work

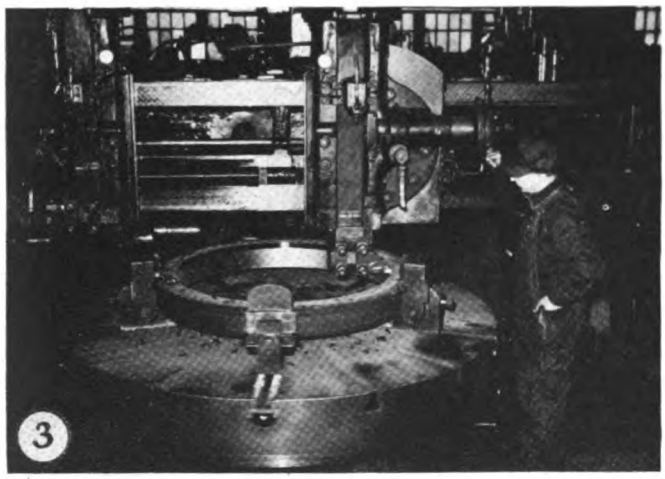
THE 11 photographs on this and the opposite page show the various set ups for a variety of locomotive and wheel machining operations in the Battle Creek, Mich., shops of the Grand Trunk Western where Carboloy has been introduced and tested on these jobs over a period of many months. In the table on the opposite page is given the important data in connection with the operations which are shown in the photographs. All of the jobs listed in the table are illustrated with the exception of the rod knuckle pin and the trailer axle operations, which are listed as Job No. 7 and Job No. 9 in the table.

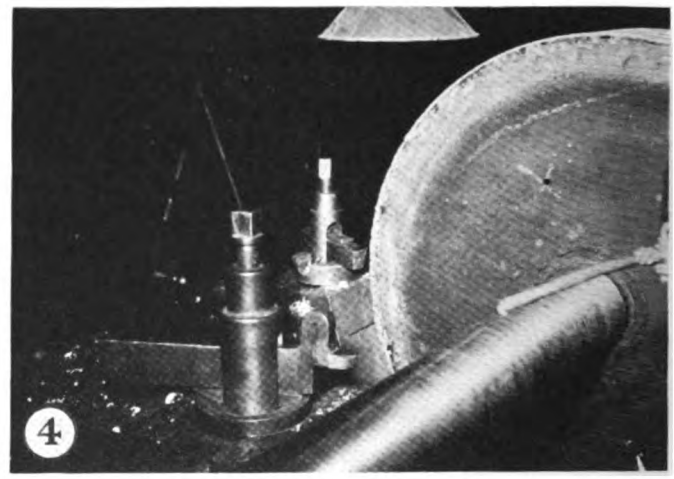
A most important consideration in the use of Carboloy tools is that they be properly ground for the job and in this particular shop a grinder such as that shown in Photo No. 11 is used on these tools. This particular tool grinder is an Excello 6-in. machine using a silicon-carbide 80-R wheel for finishing. Rough grinding is done on a floor grinder using a 12-in. 60-R silicon-carbide wheel. For grinding the cutting tool bits used in

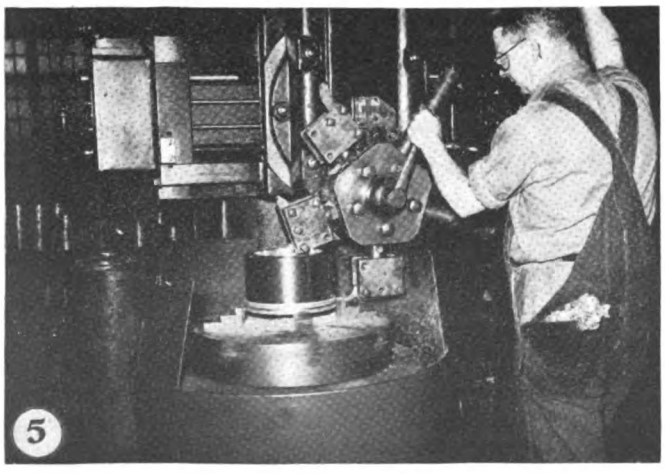
(*Text continued on page* 370)

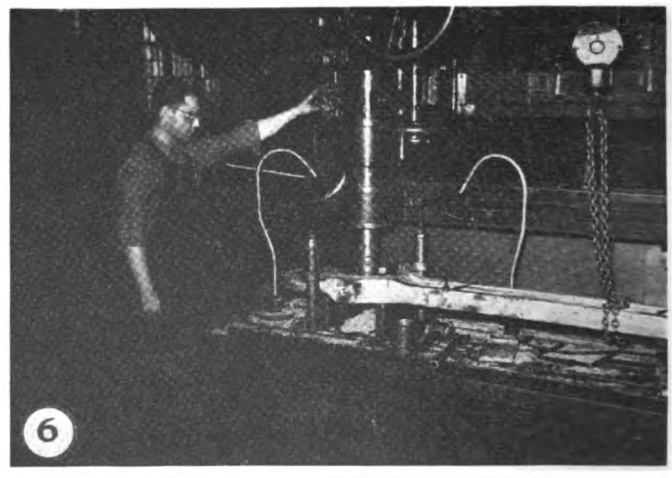






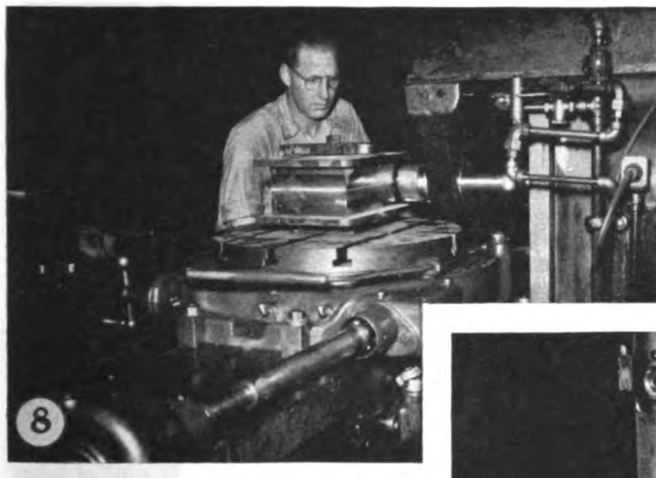


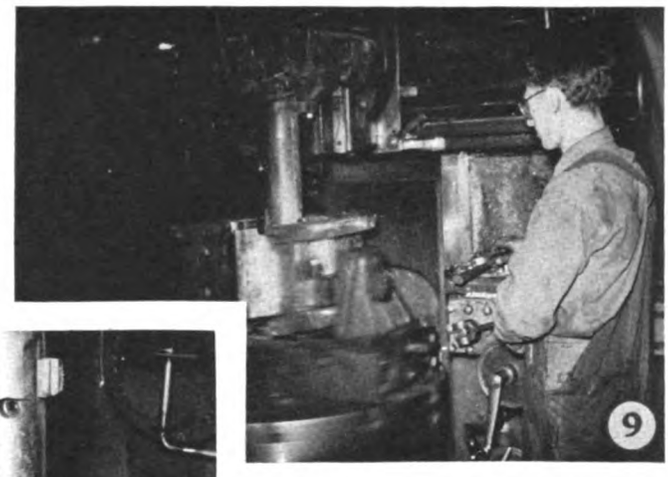




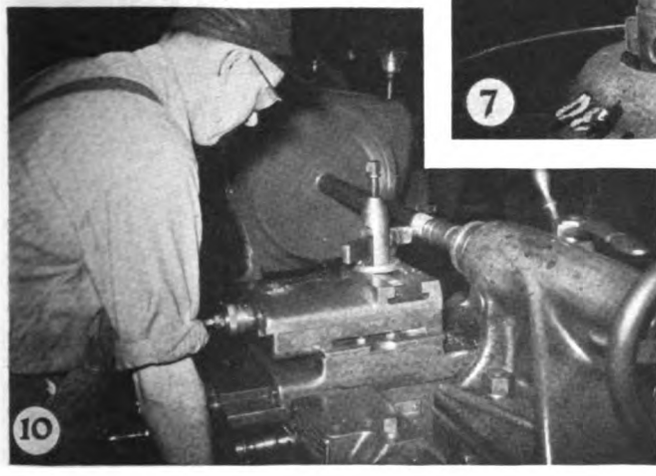
Operation Data for Carboloy Tools on Railroad Machining Work

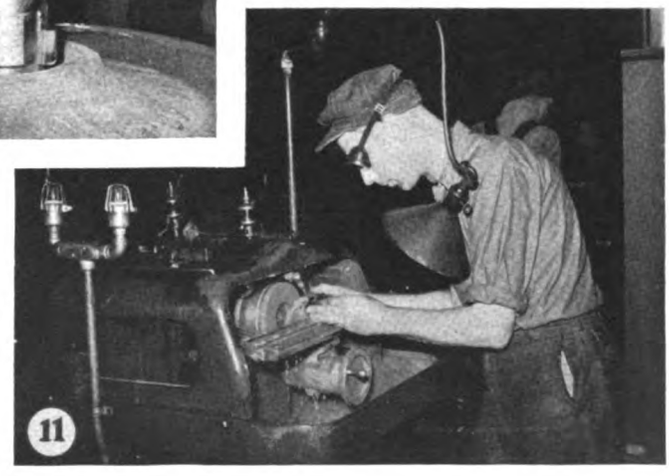
Job No.	Name of Part	Material	Operation	Machine	Cutting speed, f.p.m. Rough	Cutting speed, f.p.m. Fin.	Feed, in. Rough	Feed, in. Fin.	Depth of cut, in. Rough	Depth of cut, in. Fin.	Floor-to-floor time Carboloy hr.	Floor-to-floor time Carboloy min.	Floor-to-floor time Former tools hr.	Floor-to-floor time Former tools min.	Remarks
1	Driving box floating bushing (Photo. No. 1)	Bronze bearing metal	Bore, turn and face	42-in. Bullard vertical turret lathe	228	228	.033	.015	.313	.032	1	0	2	0	Tools machine-ground every 90 days; touched up with hand-stone occasionally
2	Driving wheel hub liner (Photo. No. 2)	Bronze bearing metal	Face, bore and turn	Bullard vertical turret lathe	460	460	.020	.020	.188	.032	0	20	0	30	Intermittent cut; tools machine-ground every 90 days; touched up with hand-stone occasionally
3	44-in. driving wheel tires (Photo. No. 3)	Steel, 45 Rockwell, C scale	Finish-bore	Betts-Newton vertical boring mill	...	216	...	.015	...	.035	0	35	0	60	32 pieces per grind; held to .001-in. limit
4	Piston head (Photo. No. 4)	Hunt-Spiller gun iron	Finish-turn	Engine lathe	...	265	...	.062	...	.062	0	15	0	20	.....
5	Side rod bushing (Photo. No. 5)	Bearing bronze	Turn, bore, face chamfer and cut off	32-in. Gisholt vertical boring mill	350	350	.062	.062	.188	.031	0	15	0	30	Tools used on variety of jobs; ground every three weeks
6	Solid side rod bearing (Photo. No. 6)	Bearing bronze	Finish bore and recess	Newton vertical rod borer	...	400	...	.031	...	.062	4 (For eight bushings)	30	8	0	Four weeks between tool grinding; jigs also helped reduce time
7	Rod knuckle pin (not shown)	Steel, 18 Rockwell, B scale	Finish-turn taper, face ends and turn body	.....	...	170	...	.015	...	varies	0	45	1	30	.....
8	Freight car wheel (Photo. No. 7)	Cast iron	Bore	52-in. Betts vertical hydraulic boring mill	90	...	.125	...	.250	...	0	5	0	5	Carboloy-400 pieces per tool grind; longer tool life justifies use of Carboloy
9	Trailer axle (Not shown)	Steel, 18 Rockwell, B scale	Finish-turn for grinding	Engine lathe	...	433	...	.007	...	.125	1	0	2	0	Five pieces per tool grind
10	Driving box bearing (Photo. No. 9)	Bearing bronze	Rough and finish bore bearing and face hub liner	42-in. Bullard vertical turret lathe	350	350	.031	.031	.375	.031	0	10	0	30	Intermittent cut; tool operates 90 days between grinds; touched up by hand occasionally
11	Main rod brasses (Photo No. 8)	Bronze	Mill sides and ends	Cincinnati No. 5 milling machine	...	500	...	15 in. per min.	...	.250	1	30	3	0	Pieces per tool grind—15
12	Pump piston rods (Photo No. 10)	Stainless steel—metal sprayed	Finish-turn after spray-spraying	Engine lathe	...	242	...	.005	...	.016	0	20	See note		Note: Pieces per grind—12; formerly had to be ground from the rough.











the Davis boring bar on cast iron car wheel work a Wilmarth & Morman grinder is used with a 6-in. 60-R silicon-carbide wheel for roughing and a 6-in. diamond wheel for finishing.

Particular attention is called to the time savings effected on these jobs; to the number of pieces that can be machined on some of the more difficult work and to the machining jobs on which the tools are ground at three- and four-month periods.

Ash Pan Hopper Castings

A boiler foreman recently developed an idea which has turned out to be a money saver. As every shop man knows, the bottom of an ash pan hopper is so planned as to accommodate a slide. This slide has a flange that slides in the groove of the casting. The usual thing to do when this groove wears out—which is often due to the abrasion of the ashes and cinders—is to throw the casting away. The idea of throwing all these good castings away led to the development of this method: a scrap casting was put on a planer and the worn part of the groove planed away, that is the bottom part, then the casting was drilled and tapped for five equally-spaced ⅞-in. studs. Next, a bar of iron about 5/8 in. by 2 in. was drilled to drop down over the studs. When this was tightened into place it made a perfect groove for the slide and whenever this slide wears out it is but a few minutes job to replace it with a new bar, as they are all drilled to a standard. On this road this method is now standard practice on all such castings when they are purchased new.

Improved Method of Applying Boiler Patches*

The old and new methods of applying boiler patches on one railroad are shown in the accompanying illustrations. The patches applied by the new method have proved satisfactory in service and have reduced the labor required for their application. Fig. 1 shows the old method used in the application of throat-sheet or knuckle patches. This method required considerable labor for scarfing the sheets, and the heating and raising of the old sheets. It resulted in the reduction of the efficiency of the patch.

Fig. 2 illustrates the new method of applying a boiler patch similar to the one shown in Fig. 1. A taper filler is built up by electric welding from the original thickness of the boiler sheet down to zero. This wedge is about 2½ in. wide and extends ¼ in. above and below the edge of the patch. This method makes it unnecessary to scarf the patch or to heat and raise the old sheets. Full efficiency is obtained as the entire thickness of the patch is retained. The patch is easy to apply as all the heating and laying up is performed from the outside which results in a reduction of the amount of labor required in the application.

Fig. 3 shows the manner of applying a patch to the back head. The defect was a crack in the outside radius.

(*Continued on next left-hand page*)

* An entry in the prize competition on boiler patches, announced in the March, 1939, issue. The names of the winners were published in the August, 1939, issue.

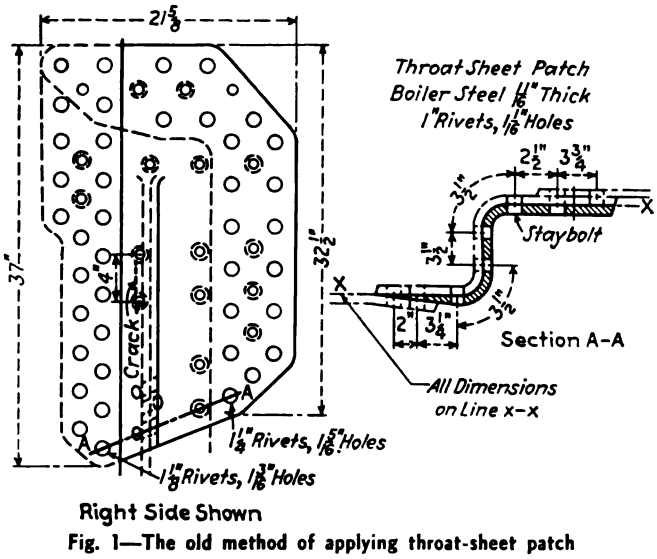


Fig. 1—The old method of applying throat-sheet patch

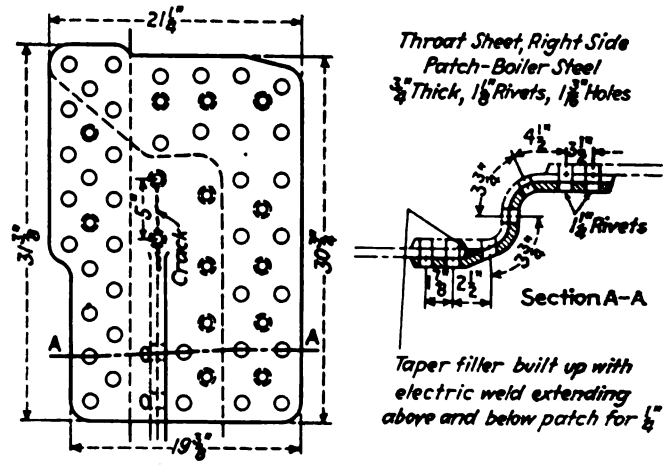


Fig. 2—The new method of applying throat-sheet patch

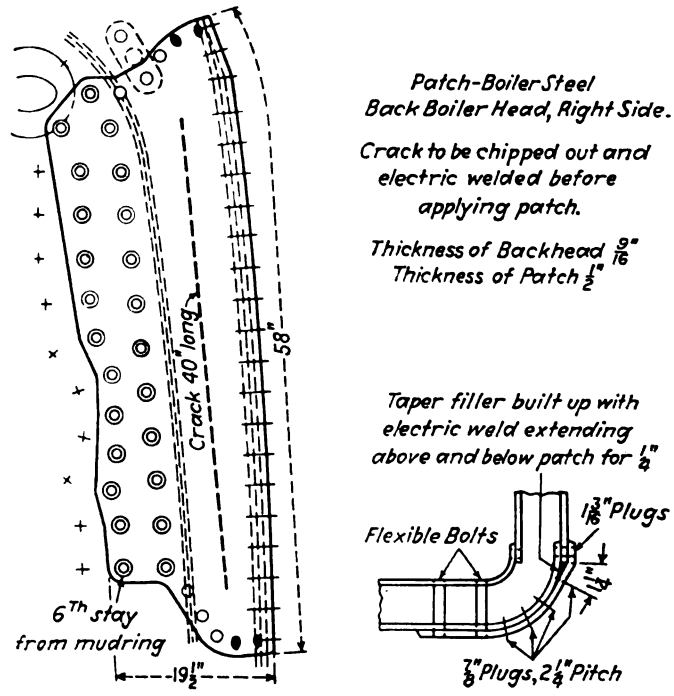
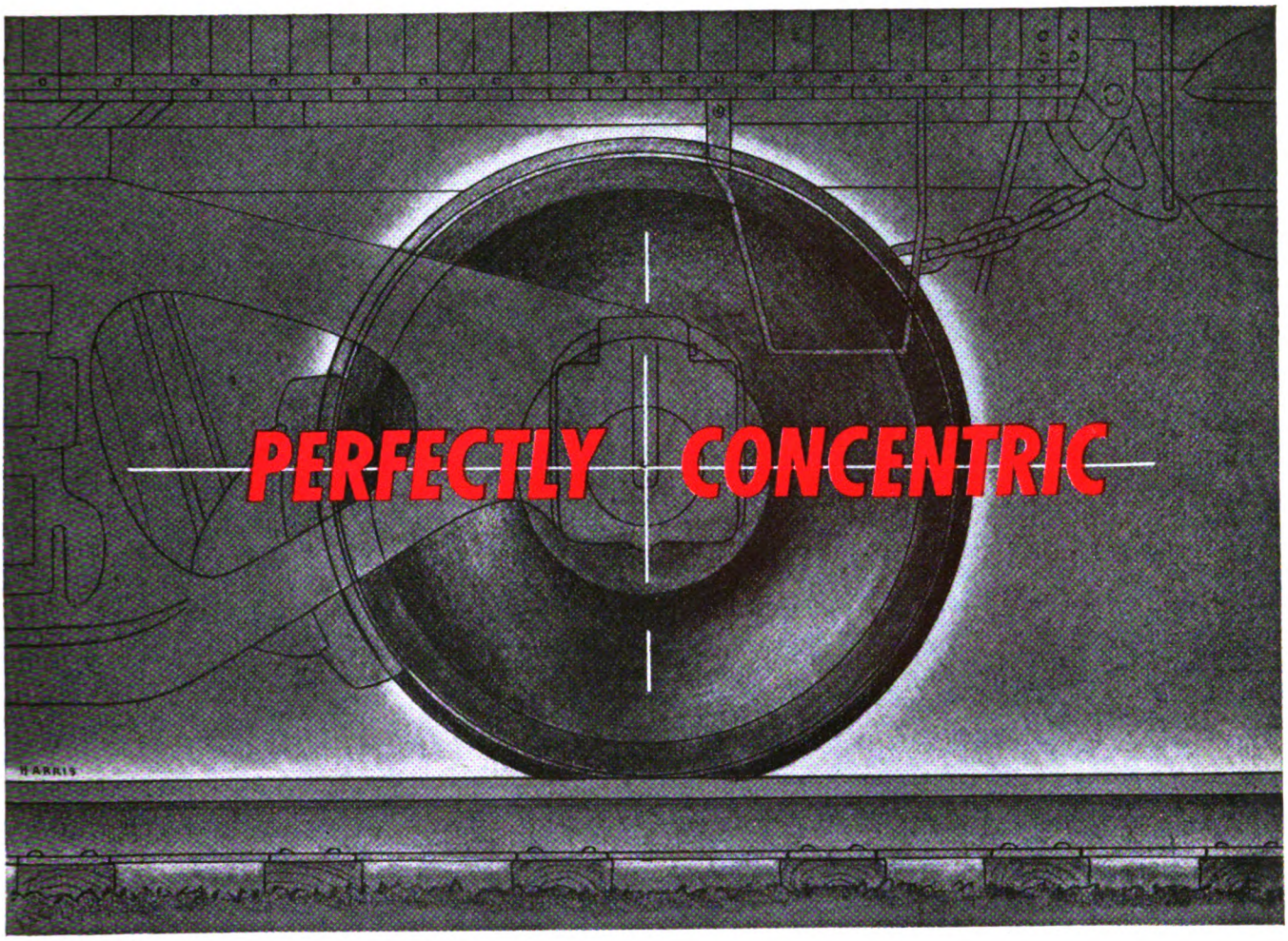


Fig. 3—Application of a patch to the back head



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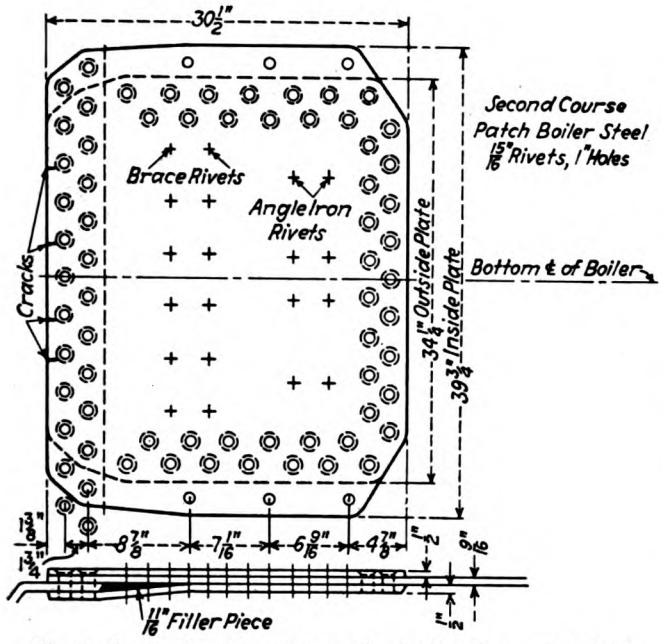


Fig. 4—Application of a patch on the shell by the same method

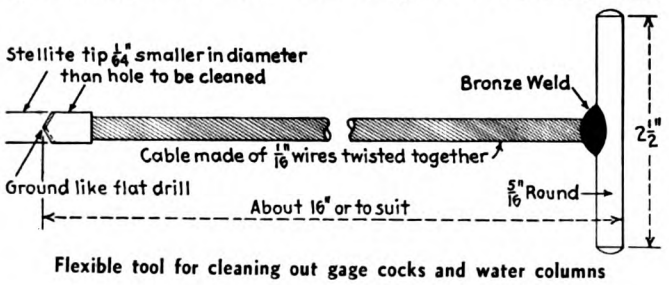
The crack was chipped out and welded before the patch was applied. Again, a taper filler is built up by electric welding similar to the one shown in Fig. 2, which eliminates scarfing and the heating and raising of the wrapper sheet. The old method of applying this patch frequently resulted in the breaking or cracking of the sheets at the rivet holes.

The former method of applying patches similar to the one shown in Fig. 4 consisted of planing or scarfing the end of the patch, heating and opening up the circumferential seams and inserting the patch and then heating and laying up the circumferential seams. The present method of applying this form of patch is shown in Fig. 4. A wedge to be used as a filler piece is machined with a width of approximately 10 in. and of sufficient length to extend ¼ in. above and below the patch. The wedge is applied to the edge of the boiler course and seal welded for about two inches at both ends. This method eliminates the cracking at the rivet holes in the boiler shell which occurred when the sheets were opened up for application of the patch by the old method.

Clean-Out Tool For Water Columns

By Arthur Havens

It had been customary in the enginehouse to clean water columns and gage cocks, at the monthly wash out period, by running a wire into the fittings to make sure these passages were not blocked with scale or sediment. This practice was prohibited and it became necessary to drill these openings, at each wash-out, to the original size of the opening. This sounds simple but when the difficulties are taken into consideration the job takes on an entirely different aspect. These passages seldom line up all the way through, thus making it impossible to use an ordinary straight drill; then there are always a million or less pipes and parts in the way adding to the trouble of getting a rigid tool of any kind through all of these openings. A simple solution to this job is the tool shown in the drawing.



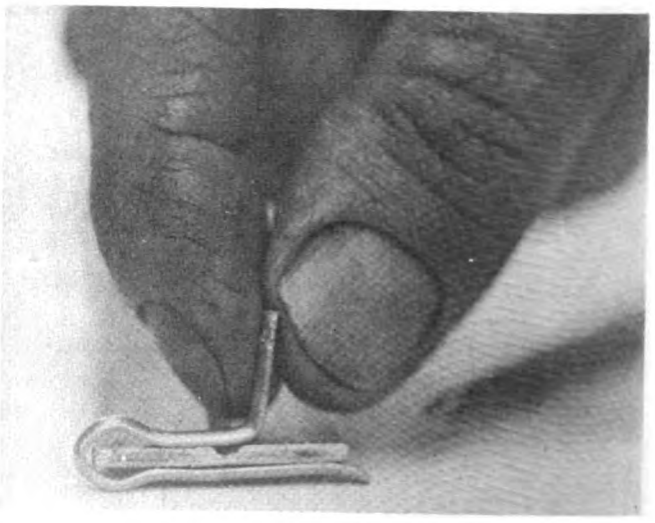
Flexible tool for cleaning out gage cocks and water columns

It is made as follows: Cut a number of wires about 1/16 in. diameter and about five feet long. Bend them in the middle and hang them on a steel rod ½ in. by 24 in. The ends of the wires—enough of them when twisted to equal a diameter just under the size drill required—are then grouped and caught in a vise. While held in this manner the steel rod is gripped in both hands and turned end for end until the wires resemble a steel cable. A section long enough to serve the purpose is then cut from this home-made flexible shaft. The next step is to coat and build up one end of the cable with Stellite. The Stellite is ground to the proper width and sharpened like a flat drill. A short piece of round stock is welded to the other end of the shaft or if one prefers a steel ring may be used. This tool will follow almost any irregular hole. The handle can be bent to avoid pipes and other bothersome parts in the cab and it is obvious that these drills can be made in any size desired with very little effort.

Spring Cotter Makes Handy Scale Grip

By Frank Bentley

The illustration shows the use of a spring cotter to make a handy finger grip for lifting and moving scales and straight edges over whiting as usually applied to various metal parts preliminary to layout work. Thin flat scales



Use of a spring clip as a handy finger grip for scales

and straight edges, when used on layout whiting, are somewhat difficult to handle. The finger ends, when picking them up or shifting to other positions, often mark and smudge the whiting. Take two spring cotters

(*Continued on next left-hand page*)



Photo courtesy Southern Pacific Company

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and fit one to each end of the scale as shown. Bend them open so they will snugly and squarely fit the flat width of the scale. Bend half of one part straight up. This makes an excellent finger grip to pick up and move the edge. Bend the end of the other half down and point with a file. The scale or edge is not too far away from the surface for marking with the scribing point, and it will not slip when held or pressed down with the finger ends. Only two small metal points touch the whited surface which keeps it clean with only the lines, circles and other layout marks clear and plain for machining.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

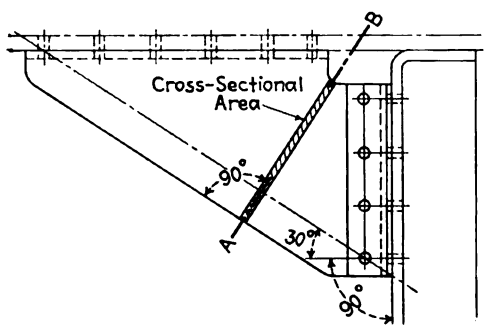
Determining Cross-Sectional Area of Gusset Brace

Q.—How is the cross-sectional area of a gusset brace for the front tube sheet of a locomotive boiler determined?—M. E. D.

A.—Gusset stays constructed of triangular right-angle plates secured to the tube sheet and shell with double angle irons, or to the tube sheet with double angle irons and flanged over at the top for connection to the shell, shall have a cross-sectional area (in a plane at right angles to the longest side and passing through the intersection of the two short sides) equal to the cross-sectional area that would be required for a diagonal stay to support the same surface.

The line representing the angle of the brace shall be a line intersecting the front rivet in the flange where riveted to the wrapper sheet and the bottom bolt in the backhead angle irons where the gusset plate fastens to the angle iron.

As an example the required cross-sectional area of the gusset shown in the diagram to support 200 sq. in.



Gusset brace for the front tube sheet

of front tube-sheet area under a working pressure of 250 lb. per sq. in. is determined as follows:

250 × 200 = 50,000 lb. = load supported by brace

The maximum allowable stress per square inch of net cross-sectional area on round, rectangular, or gusset braces is 9,000 lb.—I.C.C. rule.

50,000 ÷ 9,000 = 5.55 sq. in. = required cross-sectional area of straight brace rod

In calculating stresses on braces and their attachments, the angularity of the brace, if in excess of 15 deg. must be taken into consideration. The required cross-sectional area of the brace is divided by the cosine of the angle that the brace makes with a line drawn at right angles to the area supported. This angle is 30 deg. as shown.

Cosine 30 deg. = .8660

5.55 ÷ .866 = 6.4 sq. in. = required cross-sectional area of brace taken along line *A-B*

The A.S.M.E. Code states that the cross-sectional area of gusset stays shall be 10 per cent greater than would be required for a diagonal stay to support the same surface.

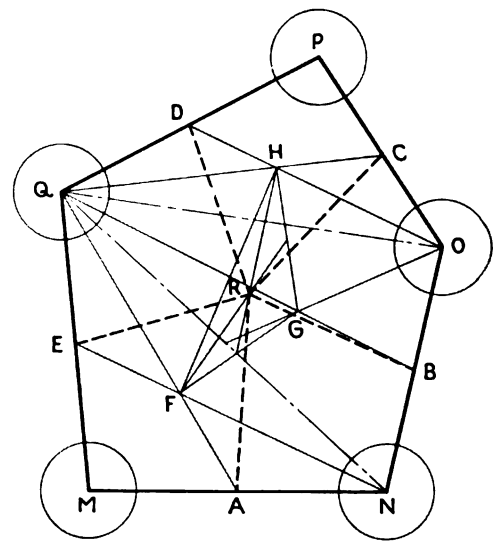
Area Supported By Unequally-Spaced Staybolts

Q.—When staybolts are unequally spaced, causing an irregular area to be supported, how is the area proportioned as to the load on each staybolt surrounding it? What is taken as the pitch of the staybolts for such an area?—F. E. C.

A.—A practical method of determining the area supported by each staybolt is illustrated in the diagram.

Area *M, N, O, P, Q* is supported by the staybolts *M, N, O, P, Q*. First, obtain the center of gravity of the area *M, N, O, P, Q* as follows:

Bisect the distances *O-P* and *P-Q* locating the points *C* and *D*. Connect *C-Q* and *O-D* with lines intersect-



A graphical method for determining the area supported by unequally-spaced staybolts

ing at *H* which is the center of gravity of the triangle *O-P-Q*. In the same manner locate the center of gravity of the triangles *N-O-Q* as *G* and *Q-N-M* as *F*.

In the same manner obtain the center of gravity of the triangle *F-G-H* as *R*. *R* will also be the center of gravity of the area *M, N, O, P, Q*.

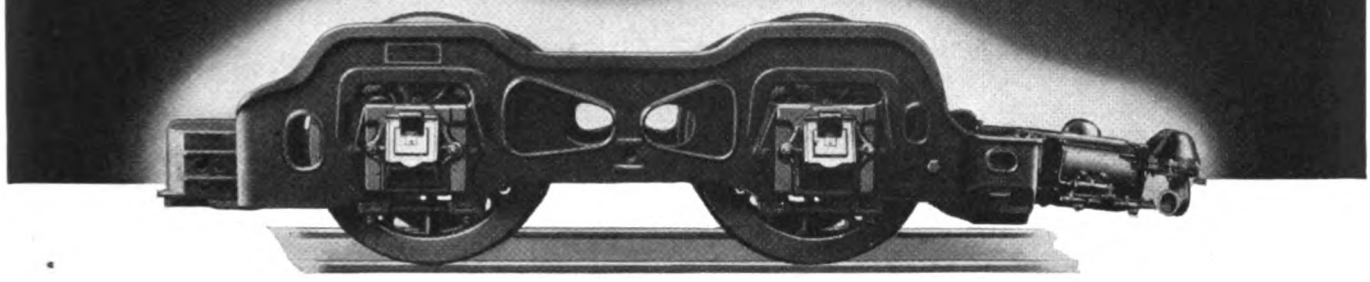
Bisect the distance *M-N* locating the point *A*, bisect the distance *O-N*, locating the point *B* and in like manner the point *E*.

Connect the points *R-A, R-B, R-C, R-D* and *R-E* with dotted lines. The area *M-A-R-E* will be supported by

(Continued on next left-hand page)

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staybolt *M*, the area *E-R-D-Q* will be supported by the staybolt *Q*, and in like manner obtain the proportional area supported by each staybolt.

In cases where the staybolting of boiler plates is unsymmetrical for reason of interference with butt straps or other construction, it is the opinion of the A. S. M. E. Boiler Code Committee that in addition to the special provisions of Pars. P-205 and P-207, it is permissible to consider the load carried by each staybolt as the area calculated by taking the distance from the center of the spacing on one side of the bolt to the center of the spacing on the other side.

Tolerance Used in Fitting Shell Courses

Q.—When fabricating cylindrical courses, what tolerance should be allowed for fitting courses together at the circumferential seams?—F. E. D.

A.—The A. S. M. E. Code states that the inside circumference of an outside course shall not exceed the outside circumference of the inside course or head by more than ¼ in., the circumference to be measured before being bolted together. The space between the edges of the ends of the plate when rolled and bolted together for butt-strap riveting shall not exceed ¼ in.

Locomotive practice in developing boiler shell courses is to lay out the circumference of the inside and outside courses to the nearest 1/16 in. based on the neutral diameters of the courses. No allowance is made. When assembling the rings, the end of the largest ring is heated and expanded enough to allow the smaller course to slip in up to the width of the circumferential seam. Shell courses are fitted with a metal to metal contact, thus eliminating the possibility of stresses being set up in the plates when they are riveted together.

Holding and Welding Firebox Sheets

Q.—In welding fireboxes we have considerable trouble holding the plates in line; that is, the opening between the sheets tends to increase as the welding proceeds. What causes this condition and can it be overcome?—R. F. D.

A.—When two plates with an opening between them are welded with bare or washed electrode, the plates will draw together as the welding progresses. The amount will depend upon the welding speed. As a rule, the greater the speed, the less is the amount of the drawing effect. There can be found a speed at which the plates will not draw together. If the welding speed is further increased as when using shielded-arc electrodes, the plates will separate while welding proceeds. In the latter case, it will be necessary to tack or clamp the ends together before beginning the welding. This condition is due to the expansion and contraction in the plate caused by the welding heat.

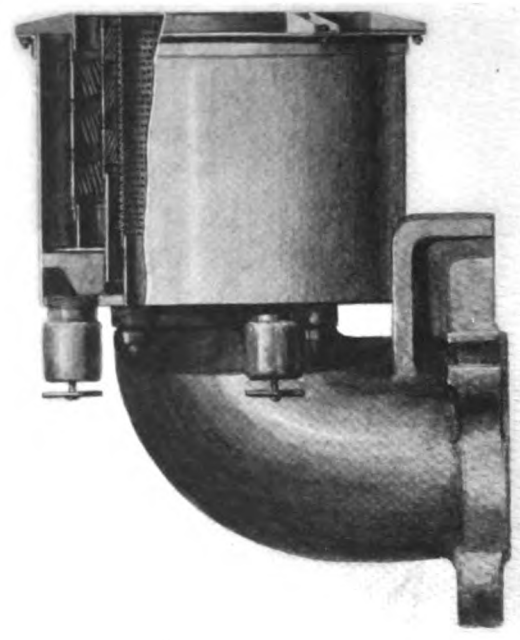
In butt welding firebox sheets, the sheets should be beveled on the fire side and, wherever possible, the weld be reinforced on the opposite side of the bevel. In preparing firebox sheets for welding, an opening of from 1/8 in. to 3/16 in. should be allowed between the sheets to obtain the full penetration of the weld. Where the shielded-arc electrodes are used, closer fitting is necessary and an opening of 1/16 in. between sheets is sufficient. The bevel should not be less than 30 deg.

After clamping the sheets in place, they should be tacked at sufficiently close intervals to hold them properly in place while welding. All necessary tacking should be done before welding is started, to prevent the sheets from being drawn out of line and also to hold a uniform opening for proper penetration.

Improved Steam Dryer

The Dri-Steam Valve Sales Corp., New York, has introduced new improvements in its standard line of locomotive steam driers. The latest design of dryer is shown in the illustration with a cut-away section showing the details of construction.

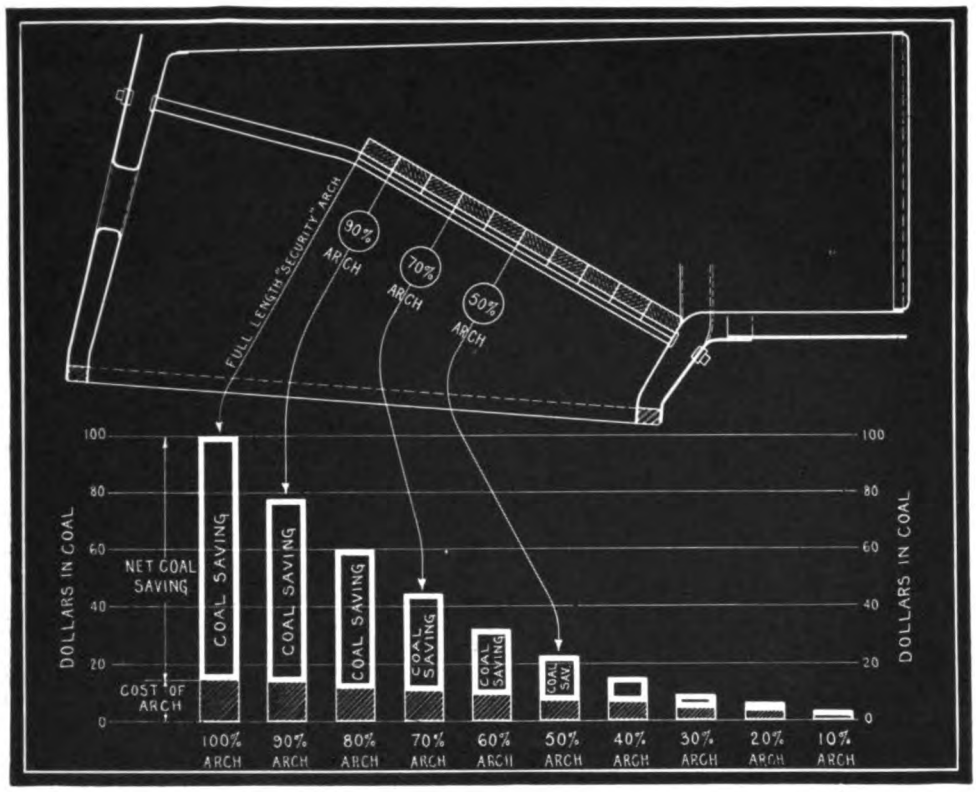
This dryer has a steel shell that surrounds three concentric cylindrical shells and between these four shells at the bottom are three annular collecting chambers. All of these collecting chambers open into a common annular receiving chamber at the bottom between the two outer shells. Referring to the three inside cylindrical shells, the outermost has continuous bands of slots or louvers inclined 30 deg. to the right of the vertical, while those in the next inside shell are inclined 30 deg. to the left. The innermost shell is pierced by thousands of small diverging nozzles which protrude from its outer surface. The bottom of the innermost cylinder opens into the standpipe. Except for the outside annular chamber all of the openings at the top are closed by a cover plate.



The improved Dri-Steam locomotive steam dryer with section cut-away to show its construction

In operation, steam from the top of the steam dome enters vertically through the outside annular opening and passes in thin streams through the louvers in the first inside cylinder into the middle collecting chamber. The inclination of the louvers produces a continuous downward helical thrust in a counter-clockwise direction to the steam flow. This action forces the separated water to the bottom as the steam reverses sharply to enter the oppositely inclined louvers in the next inside cylinder where the foregoing action is repeated in a clockwise direction in the inner collecting chamber. Here the rapidly whirling steam scrubs across the protruding nozzle tips before combing through the nozzle openings into the interior of the inside cylinder and then entering the standpipe. Check valves are applied to the receiving chamber and permit the free drainage of the water into the boiler, but close instantly to prevent backflow, should syphoning occur.

(*Turn to next left-hand page*)



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Willkie Notification Taxes Railroad Facilities

Elwood, a small town of 12,000 inhabitants, in a farming district of Indiana, was the center of interest in this country and much of the world, also, when on August 17 Wendell Willkie was formally notified of his nomination for the Presidency. It is about 160 miles from Chicago and is served by single-track lines of the Pennsylvania and the Nickel Plate. Naturally it proved to be a real problem for the railroads to adjust their facilities to meet the emergency. This was not simplified by the fact that much passenger equipment was still assigned to handling of troops to the summer maneuver camps. Thirty-five trains brought more than 20,000 people to the town within a period of about five hours. Of the 29 trains handled by the Pennsylvania, 15 came from the North and 14 from the East. It required some ingenuity to unload these trains on a single-track line, store 330 cars and 29 locomotives and service them, and then, after the ceremony, to spot, reload and dispatch the trains on a 10-minute headway. The Nickel Plate had a somewhat easier task in handling its six special trains, three from the East and three from the West. Many special facilities had to be installed by both roads and a considerable number of employees had to be brought in for the occasion.

"Coach-Sleepers" Stimulate Business

The Pullman Company has been experimenting with two experimental coach-sleepers on the North Coast Limited of the C. B. & Q.—N. P. and the Empire Builder of the C. B. & Q.—G. N. between Chicago and Seattle, Wash. These have an aisle down one side of the car with ten compartments, five of them to seat and sleep three persons each and five arranged to accommodate six persons each. The berths are arranged in three tiers and during the daytime disappearing partitions between the compartments add to the spaciousness. So successful have these cars proven that two additional ones are being made. The charge for the service between Chicago and Seattle is $5 for the accommodation, the rail ticket costing $39.50. Questionnaires from the first 496 passengers carried disclosed that in the absence of these sleepers 33.5 per cent of the passengers would have used tourist cars, 10.1 per cent standard Pullmans, 38.3 per cent a railroad coach, 9.5 per cent, bus; 6.8 per cent automobile; 0.6 per cent, airplane, and 1.2 per cent would not have made the trip. Most of the passengers were vacation travelers, but 16.4 per cent were commercial, 5.6 per cent migratory, and 3.1 per cent emergency. The great majority found the service satisfactory, only 3.7 per cent reporting unfavorably.

Railroad Brotherhoods Oppose Draft Bill

The five railway operating brotherhoods have taken a strong stand against the Burke-Wadsworth Military Training Bill. A letter signed by their presidents concludes with this statement: "These organizations are wholeheartedly in accord with the establishment and maintenance of an adequate national defense, and their membership will not be found wanting in any support of such proper measures, but we are convinced that under present conditions the regimenting of our people according to the contemplated military pattern is unnecessary and is an infringement upon the civil liberties which they may reasonably expect to enjoy." A preceding paragraph, which enumerates the reasons for this decision, reads as follows: "Compulsory military service in time of peace is the very antithesis of freedom. It involves an infringement of the very principles of democracy which it is invoked to defend. It imposes upon the individual a mandate to give service which he may not be in position to render without serious sacrifices on the part of himself or his family, or both, and this at a time when there are thousands of other individuals who would be glad to avail themselves of the opportunity to serve if such opportunity were not denied by the restrictive rules observed by the recruiting service."

S. 2009

The Wheeler-Lea omnibus transportation bill S. 2009 has again come to life. Congress, held in session during the summer months because of the national defense program, apparently found time in its spare moments to give it consideration. Quite probably, also, the leaders of the transportation brotherhoods, who sabotaged it and forced it back into conference, helped to bring it out of that committee when they found what the boys back home thought of their shortsighted action. At any rate, it passed the House on August 12 by a vote of 246 to 74, with compromise "labor-protection" provisions and a modified Jones agricultural rate amendment. Senator Wheeler, chairman of the Senate Committee on Interstate Commerce, has indicated that he will call it up in that body when the debate on the conscription bill is concluded. If past declarations of the President about his concern for the railroads mean anything, he should sign the bill, but after his curious reversal in form in vetoing the "bridge bill", it is unsafe to hazard any prediction as to what course he will follow. The amended bill, as it now stands, will be some improvement over legislation now on the books, but as the Railway Age points out, it will give the carriers, at most, only about 40 per cent of what they asked for.

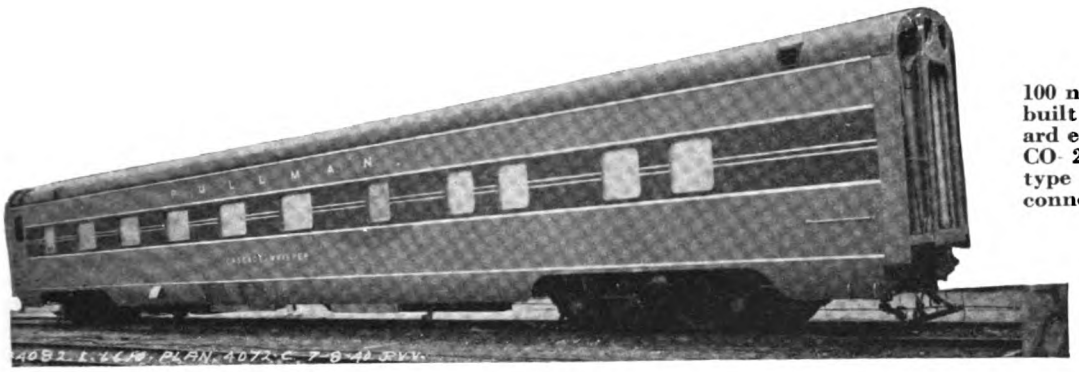
Army Maneuvers Make Heavy Demands on Railroads

The Army maneuvers in this country in August required intensive use of railroad facilities at a time when the vacation tourist business was at its height. In three of the heaviest troop movement days, August 4, 5 and 6, the railroads moved nearly one-sixth as many men as were transported during the entire 31 days of the heaviest month's movement during the World War. From July 30 to August 12, the railroads moved 150,000 troops of the regular Army and National Guard and their equipment from all parts of the country to the four Army Areas. In spite of bad weather conditions in some sections, the trains were moved close to schedule. Army authorities were said to be pleased with the results. The Quartermaster General's office is also said to have pointed out that it is highly improbable that the railroads will be called upon, even in war time, to handle more troops in a similar period than were transported during the peak days of the August movement.

Mexican Railway Employees Don't Like to Economize

President Cardenas of Mexico in June instructed the union officers and the Workers Administration of the National Railways of Mexico to reorganize the service, including certain freight rates, and to reduce operating expenses. He also stressed the importance of resuming payment of obligations with American firms that had been held in abeyance since February. The board recommended changes which would effect a saving of 1,800,000 pesos a month. These measures included among other things, a reduction in salaries to what they were on May 1, 1938, suppression of unnecessary posts, that personnel be compelled to dispose of vacations in time instead of receiving its equivalent in cash, that a maximum of motive power be utilized by completing train loads, the reestablishment of a most rigid disciplinary regime and that authority be reinstated to heads of departments to apply discipline. The Union of Mexican Railway Workers objected to these changes and as a result of the controversy General Manager Juan Gutierrez and the Board of Workers Administration have been forced to resign.

(Turn to next left-hand page)



100 new Pullman Cars—built by Pullman Standard equipped with BARCO 2″ FT-2 horizontal type car steam heat connections.

BARCO

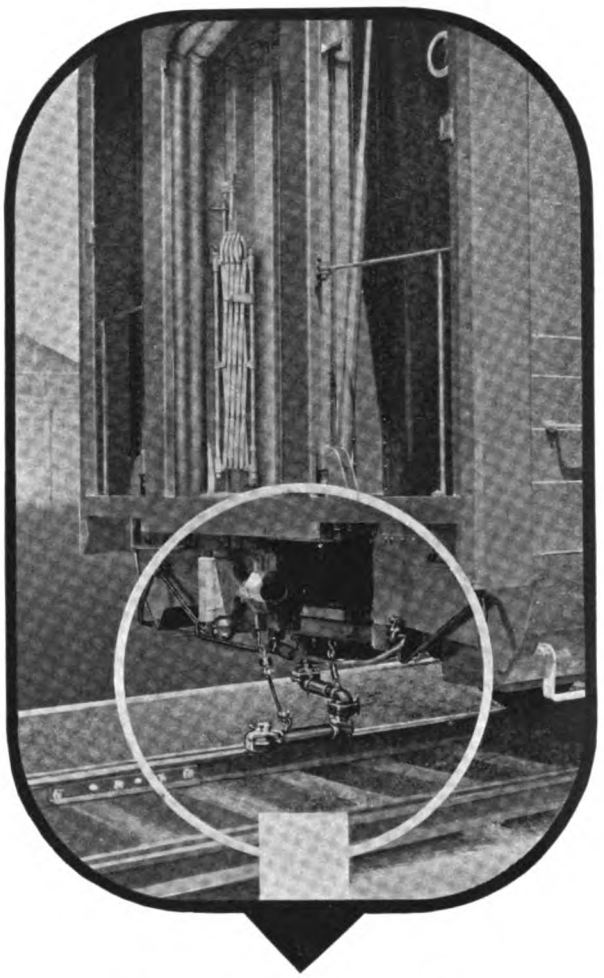
STEAM HEAT CONNECTIONS FOR *Streamlined* CARS

contribute to more dependable car heating with less maintenance.

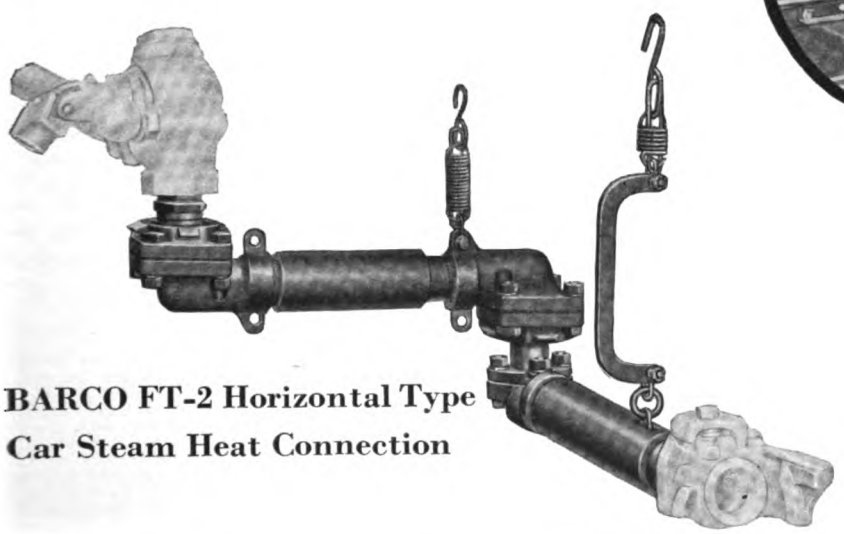
Only 2 wearing points per connection using one BARCO long life non-metallic gasket in contact with one hardened forged alloy steel ball at each wearing point.

The combined swivel and angle movement available at each of these points provide maximum flexibility with minimum number of wearing parts.

Light in weight—simple in design—low in cost of maintenance.



Available in either 2″ or 2½″ Sizes



BARCO FT-2 Horizontal Type Car Steam Heat Connection

BARCO MANUFACTURING COMPANY
1811 W. Winnemac Ave. Chicago, Illinois

In Canada:
THE HOLDEN COMPANY, LTD.
Montreal — Moncton — Toronto — Winnipeg — Vancouver

NEWS

Two New Members Join A. A. R.

THE Wheeling & Lake Erie and the Pittsburgh & West Virginia have become members of the Association of American Railroads, according to an announcement by that organization on August 16.

172 Experimental Tank Cars for A. c. f.

THE American Car and Foundry Company has been granted authority by the Interstate Commerce Commission to construct for experimental service in the transportation of caustic soda solution and petroleum products a total of 172 tank-car tanks fabricated by the fusion welding process.

Equipment Purchasing and Construction

The Chicago, Burlington & Quincy.—The Burlington will shortly begin the construction of 1,000 single sheathed 50-ton box cars in their own shops.

A contract has been awarded the Karnoff Construction Company, Kansas City, Mo., by the C. B. & Q. for the construction of a brick and concrete enginehouse at North Kansas City, Mo.

Company forces of the C. B. & Q. are making improvements at the enginehouse and local switching yards in Ottumwa, Iowa, to expedite the servicing of locomotives and movement of fast trains. Yard trackage is being improved and cinder, sand and coal facilities rearranged so that eastbound locomotives can take coal, water and sand and drop cinders at one spotting.

The Chicago, Milwaukee, St. Paul & Pacific.—The Milwaukee is completing the construction of 2,000 50-ton box cars and 25 caboose cars in their own shops.

The Chicago, Rock Island & Pacific.—The Rock Island has been authorized by the district court to purchase 800 box cars, 200 automobile cars and 100 gondola cars at an approximate cost of $3,090,000, and to rebuild 300 flat cars and remodel 100 coal cars in the company's shops at an estimated cost of $263,000.

Mobile & Ohio.—The M. & O. has asked the Interstate Commerce Commission for authority to assume liability for $2,700,000 of 2½ per cent equipment trust certificates, maturing in 15 equal annual installments of $180,000 on August 1 from 1941 to 1955, inclusive. The proceeds will be used as part payment for equipment costing a total of $3,399,000, and consisting of 1,000 40-ton, 40 ft. 6 in. box cars; 250 50-ton, 33 ft. one-fourth in. self-clearing hopper cars; and two 2,000 hp. Diesel-electric locomotives.

The petition states that the company will sell to the car builders 2,000 reconditioned and rebuilt trucks and 1,000 rebuilt axles, costing $472,500, which, together with $226,500 in cash, will constitute the difference between the proceeds of the certificates and the total cost of the equipment. The issue has been sold at 100.099 to Salomon Brothers & Hutzler.

Army and Navy Do Much Buying Locally

THE War and Navy Departments have issued a public statement that current information concerning national defense purchases can best be secured from the field offices which the departments have established throughout the country rather than by writing to Washington, D. C., or by sending representatives to the capital. The Navy Department maintains 27 major field purchasing offices in 23 cities, while the War Department has 46 major field procurement offices in 22 cities.

For the information of manufacturers, the Department of Commerce has issued a 16-page booklet giving information concerning these offices. Partial lists of materials being purchased by various agencies of the War and Navy departments appear therein, together with the special field procurement and purchasing offices which have been established. Of particular interest to railroad supply companies will be those offices set up by the Engineers Corps of the Army which is interested, among other things, in air-brake equipment, railroad cars, air compressors, gasoline and steam engines, electric motors and gasoline and steam locomotives.

Orders and Inquiries for New Equipment Placed Since the Closing of the August Issue

Locomotive Orders

Road	No. of Locos.	Type of Locos.	Builder
Akron, Canton & Youngstown	2	2-8-2	Lima Loco. Wks.
Atlantic Coast Line	18	2,000-hp. Diesel-elec.	Electro-Motive Corp.
Southern Pacific	20	4-8-4	Lima Loco. Wks.
Chicago & North Western, Union Pacific, Southern Pacific	1[1]	Diesel-elec	Electro-Motive Corp.
Chicago & North Western, Union Pacific	1[1]	Diesel-elec	Electro-Motive Corp.

Locomotive Inquiries

Chesapeake & Ohio	10	2-6-6-6	.....
Duluth, Missabe & Iron Range	8	Locos.	.....

Freight-Car Orders

Road	No. of Cars	Type of Car	Builder
Charleston & Western Carolina	35	50-ton hoppers	Pull.-Std. Car Mfg. Co.
Chicago & North Western	60[2]	70-ton hoppers	Gen. Amer. Transp. Corp.
Chicago, Indianapolis & Louisville	100	50-ton hoppers	Pull.-Std. Car Mfg. Co.
Louisville & Nashville	100	Box	Pull.-Std. Car Mfg. Co.
	100	Automobile	Pull.-Std. Car Mfg. Co.
Norfolk & Western	500	Box	Ralston Steel Car Co.
Southern Pacific	500	Box	Gen. Amer. Transp. Corp.
	500	Box	Pressed Steel Car Co.
	500	Box	Bethlehem Steel Co.
	500	Automobile	Mt. Vernon Car Mfg. Co.
	350	Hopper	American Car & Fdry. Co.
	125	Flat	Company Shops
	15	70-ton gondolas	Company Shops
	50	Cabooses	Company Shops
Union Pacific	100	70-ton cement	Gen. Amer. Trans. Corp.

Freight-Car Inquiries

Louisiana & Arkansas	50, 75 or 100	70-ton hopper	.....

Passenger-Car Orders

Road	No. of Cars	Type of Car	Builder
Atlantic Coast Line	17	Coaches	Edw. G. Budd Mfg. Co.
Chicago & North Western, Union Pacific, Southern Pacific	17[1]		Pull.-Std. Car Mfg. Co.
Chicago & North Western, Union Pacific	17[1]		Pull.-Std. Car Mfg. Co.
Southern Pacific	51[3]		Pull.-Std. Car Mfg. Co.

[1] For operation between Chicago and San Francisco, Cal., and Los Angeles on a 39¾ hr. schedule. To cost more than $4,000,000. One, the City of San Francisco will be jointly owned and operated by the Chicago & North Western, the Union Pacific and the Southern Pacific and the second by the North Western and the Union Pacific. Each of the Diesel locomotives will have 6,000 hp. consisting of three 2,000 hp. units. Except for minor differences in available Pullman accommodations, the four trains will be identical. All cars of the new trains will be of aluminum-alloy construction and of the same general contours as the streamliners developed by the three railroads for their transcontinental service, with modifications to make for more effective streamlining. The color design of the trains provides for a harbor mist gray roof, with the sides an armour yellow, trimmed with scarlet-red striping and lettering. Fluorescent lighting will be used in the club and lounge cars, the diners and chair cars. All cars will be self-contained as to air-conditioning and lighting. The trains will be equipped with inter-communicating telephone systems and will have electric heat in addition to the regular steam heat.

[2] Authorized by the Federal District Court under a 15-year lease-purchase plan. During the remainder of 1940, 500 48-ft. drop end gondola cars and 500 40-ft. drop bottom gondola cars will be reconditioned in North Western's shops.

[3] Lightweight streamlined passenger train cars. Some of these cars will be used for re-equipping the "Larks," operating between San Francisco, Cal., and Los Angeles. The new consist of the Larks will also include 26 new lightweight Pullman sleeping cars with drawing room, bedroom, and roomette accommodations. The balance of the 51 cars will be used on the noon "Daylights" to incorporate refinements in design of the more recently built morning Daylights; on the "San Joaquins;" on the "Coaster;" on the "Californian," between Chicago and Los Angeles; on the "Sunset" between San Francisco and New Orleans; and on the "San Francisco Challenger" and the "Pacific Limited" between Chicago and San Francisco.

Stoker Order Exemption Sought by N. Y. O. & W.

THE New York, Ontario & Western has asked the Interstate Commerce Commission to postpone the operation of its recent order requiring all locomotives in heavy freight service to install or be equipped with automatic stokers in so far as it affects 26 of its 184,000 lb., hand-fired, coal-burning locomotives. The petition of the road points out that the installation on these locomotives would cost $78,000 and that such an installation would be "economically unsound and wasteful" in view of the fact that they have been in service for some 30 years.

19,765 New Freight Cars on Order August 1

CLASS I railroads on August 1, 1940, had 19,765 new freight cars on order, according to the Association of American Railroads. On July 1, 1940, they had 16,933 on order, and on August 1, last year, there were 8,473. The new cars on order on August 1, this year, included 11,565 box, 7,218 coal, 360 stock, 250 flat, 50 refrigerator and 322 miscellaneous cars.

Class I roads on August 1, this year, also had 168 new locomotives on order, of which 115 were steam and 53 electric and Diesel-electric. On July 1, 1940, there were 124 new locomotives on order, of which 97 were steam and 27 were electric and Diesel-electric. New locomotives on order on August 1, last year, totaled 118 which included 72 steam and 46 electric and Diesel-electric.

In the first seven months of 1940, the railroads put in service 40,416 new freight cars compared with 10,302 in the same period last year. Of the total number of new freight cars placed in operation in the first seven months of this year, there were 18,640 box, 19,876 coal, 606 flat, 595 refrigerator, 88 stock and 611 miscellaneous cars. In the first seven months this year, the railroads also put in service 201 locomotives, of which 58 were steam and 143 electric and Diesel-electric. Installed in the first seven months last year were 139 new locomotives, of which 20 were steam and 119 electric and Diesel-electric.

Freight cars and locomotives leased or otherwise acquired are not included in the above figures.

W. P. Chrysler Dies at 65

WALTER P. CHRYSLER, who left railroad service after 20 years service to enter the automobile manufacturing industry and became one of its leading executives, died at his home in Great Neck, N. Y., of a cerebral hemorrhage on August 18 at the age of 65. Born the son of a Union Pacific locomotive engineer, Mr. Chrysler entered railroad service in 1892 at the age of 17 as a machinist's apprentice in the Union Pacific enginehouse at Ellis, Kan. Later he was made a general foreman in the Colorado & Southern shops at Trinidad, Colo. After some years as a journeyman machinist he worked with several Western roads as a general foreman and master mechanic. He was appointed superintendent motive power and machinery of the Chicago Great Western in 1908 at the age of 33.

Two years later Mr. Chrysler went into the locomotive manufacturing business as assistant manager of the Pittsburgh Works of the American Locomotive Company, becoming manager the following year. In 1912 he forsook the railroads and their equipment suppliers to join the Buick Motor Company as works manager. He rose rapidly in the automobile business, becoming president of Buick and in 1920 taking over the management of the Willys-Overland Company. He brought out his own car later and made the Chrysler Corporation one of the "big three" in automobile manufacturing. Mr. Chrysler was a director of the New York Central at the time of his death.

C. & N. W. Shop Foremen's Status

BECAUSE the American Railway Supervisors Association, Inc., has withdrawn the petition which instigated the proceeding, the Interstate Commerce Commission has discontinued that phase of its Ex Parte No. 72 (Sub-No. 1) investigation which had to do with the status under the Railway Labor Act of general foremen in the motive power and car departments of the Chicago & North Western.

Monopoly Charge Denied by Pullman

THE Pullman group of companies has not violated and is not now violating any law of the United States, according to D. A. Crawford, president of Pullman, Inc., in a second quarter statement sent stockholders on August 6. The Department of Justice on July 12, as reported in the August *Railway Mechanical Engineer,* filed a complaint in the federal district court at Philadelphia, Pa.

"The action," the report to stockholders said, "attacks a business which during its long history since incorporation in 1867 has developed naturally into the present large-scale operation, as the result of economic forces and in response to the demand of the railroads and the public for sleeping car service on a unified nationwide basis that could best be rendered by the Pullman system of pooled operation. The provision in connection with this extensive travel service, of facilities for the manufacture of standardized and well-adapted equipment under the advantageous condition of concentrated production, is a further natural development that began early in the history of the business and parallels similar provision by many railroads and other public utilities.

"The bill of complaint filed in this case is incorrect in many statements alleged to be fact, and is wholly mistaken in its allegations with respect to the spirit and manner in which the Pullman manufacturing and car-operating businesses have been conducted for so many years. There has been no change of principle or practice in the conduct of either of these businesses following the introduction in recent years of new types of equipment and new methods of passenger transportation, and there is no warrant for this present belated action except as it may be found in an apparent general assault upon large-scale business under the federal anti-trust laws.

"While experience has indicated the advisability of presenting in court, rather than in a publicity contest with a government agency, the defense against legal attacks of this kind, it is nevertheless desirable that stockholder-owners of the assailed companies be informed that the basic allegation of restraint of trade made by the Department of Justice in this case, depending upon the assertion that Pullman has used its contract relations with the railroads to discourage or prevent the introduction of modern types of lightweight passenger equipment is clearly disproved by the record facts that Pullman—(a) Has furnished to the railroads several hundred lightweight sleeping cars of the most modern type, (b) has employed more than $25,000,000 of its resources in financing the investment required to place this new equipment in service, (c) has sought vigorously to extend such improved service on the railroads, and (d) today has additional supplies of such equipment in the course of manufacture or on hand awaiting assignment to the railroads.

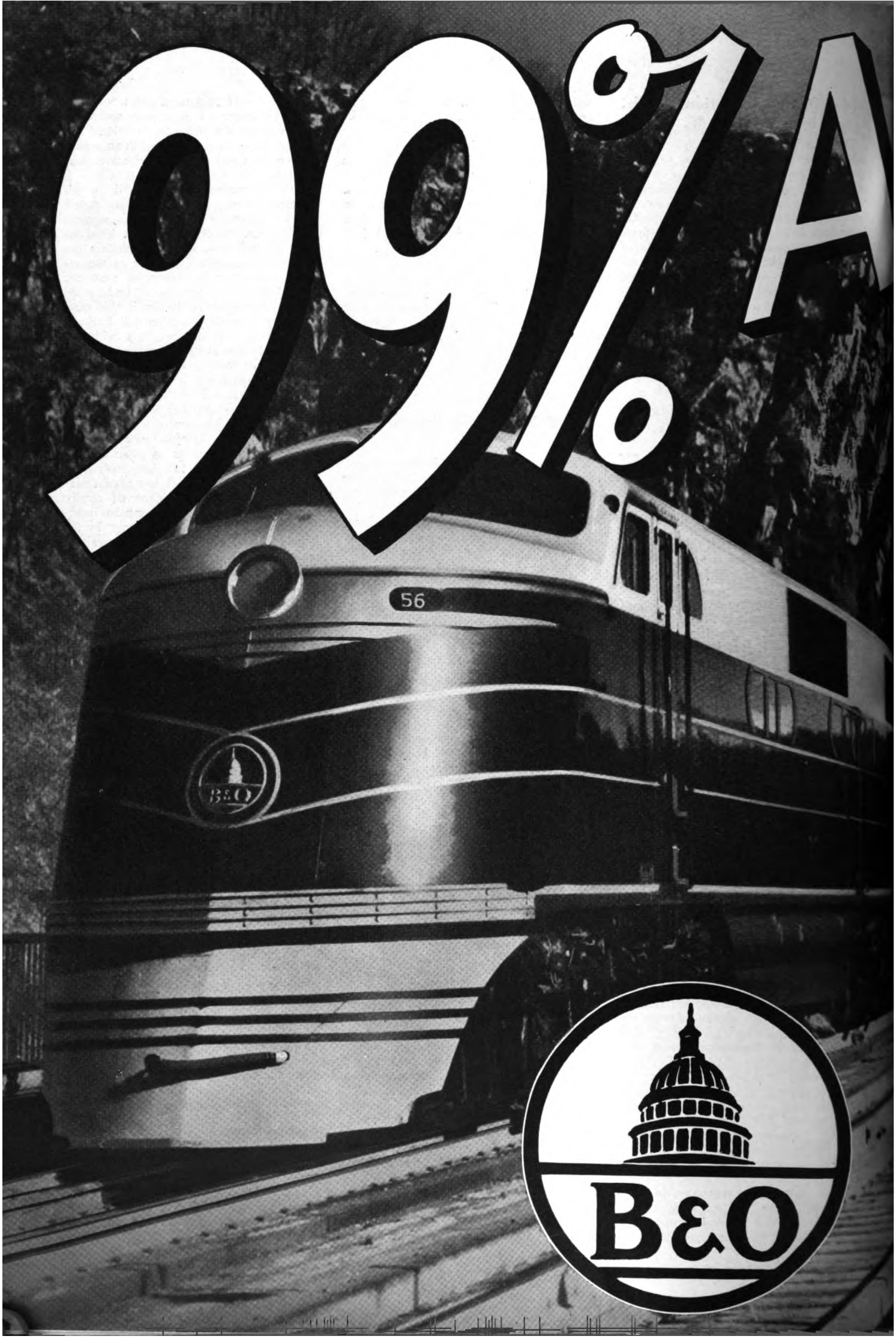
"Concurrently the Pullman-Standard Car Manufacturing Company pioneered in the development of lightweight passenger car structures, built the first practicable separate cars and unit trains of that type, and thereafter has continued the development and encouraged the purchase and use of such equipment by the railroads, with the result that it has built more of the modern widely-accepted types of such passenger equipment than any other carbuilding concern. This whole charge, that the Pullman group of companies has obstructed or grudgingly permitted the development and use of modern lightweight passenger equipment, falls to pieces when subjected to the impact of fact.

"It is the considered opinion of the management and counsel of the Pullman group of companies, that these companies have not violated and are not now violating any anti-trust or other law of the United States; and further, that this suit will be successfully defended and should not therefore occasion anxiety to stockholders."

"Head End" Safety Poster

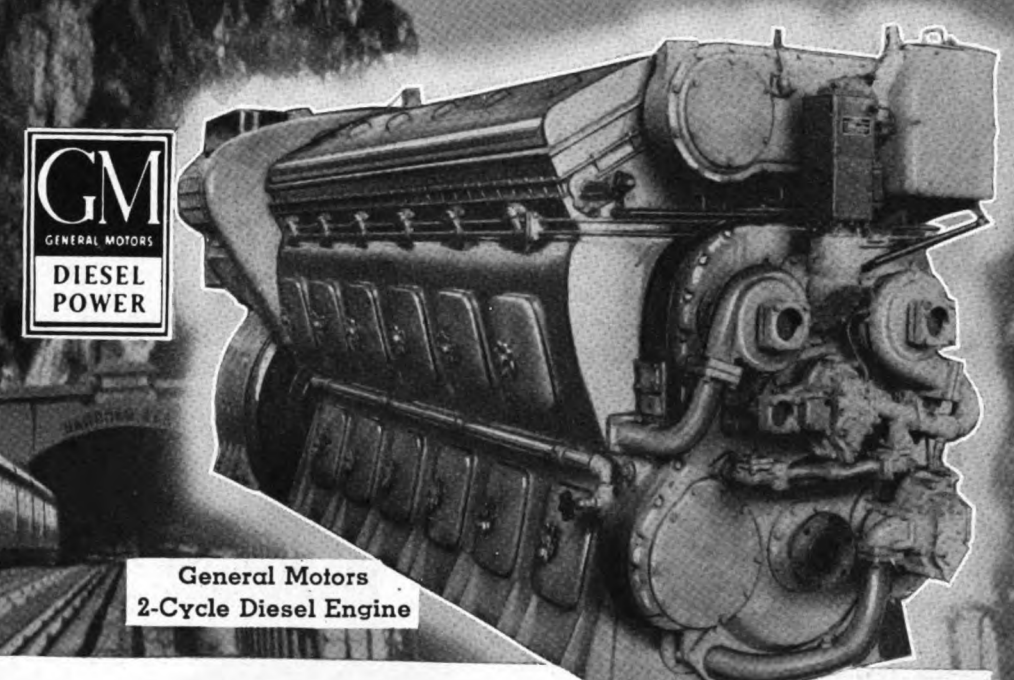
LITERATURE for the September installment of the A. A. R.'s "All the Year-Every Year Safety Program" deals with safety as applied in the locomotive cab. The large poster for public display points out that "A careful 'head-end' crew is a good start for a safe trip," while the accompanying circular contains a series of safe procedures as applied to the locomotive cab. The material, much of which was contributed by G. F. Baker, road foreman of engines, Atlantic Coast Line, covers such factors as proper bracing while handling stoker slides, the possibilities of accidents in connection with grate shaker arms, safe footing while oiling machinery, climbing out of cab windows and other routines peculiar to the head-end.

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99%A
56
B&O
B&O

vailability

SIX B.&O. DIESELS OPERATE 3,441,916 MILES IN PASSENGER SERVICE



General Motors
2-Cycle Diesel Engine

SIX 3600 Hp. EMC Diesel passenger locomotives entered service on the Baltimore and Ohio—two in May and June, 1937, two in January, 1938, two in June, 1938. Up to June 30, 1940, these locomotives have operated 3,441,916 miles with an average availability of 95.5 per cent. Diesel locomotive No. 56 on the Capitol Limited, which operated every day for an entire year without missing a trip, has to its credit 515,485 miles with 99.3 per cent availability.

Typical of EMC Diesel performance, these records are being made in fast passenger service without excessive top speeds but with high average speed consistent with safety, passenger comfort, and minimum wear on rolling stock and track. No other type of motive power can equal this performance.

ELECTRO-MOTIVE CORPORATION

SUBSIDIARY OF GENERAL MOTORS LA GRANGE, ILLINOIS, U. S. A.

Supply Trade Notes

JOHN E. WRIGHT has been appointed sales agent for American Steel Foundries, at St. Louis, Mo., succeeding Walter C. Doering, vice-president, deceased.

◆

R. G. JUSTUS, representative for the Westinghouse Air Brake Co. in the Southwestern district, with headquarters at St. Louis, Mo., has been appointed manager of industrial sales at Wilmerding, Pa.

◆

WILLIAM H. HECKMAN, sales representative of the T-Z Railway Equipment Company, Chicago, has been appointed sales engineer of the Sargent Company, Chicago.

◆

ROBERT G. ALLEN, formerly sales manager of the Walworth Company, Greensburg, Pa., has been elected president and a director of the Duff-Norton Manufacturing Company, Pittsburgh.

◆

WILLIAM C. TYLER, formerly mechanical engineer and superintendent of the manufacturing division of the William E. Pratt Manufacturing Company, has been appointed chief mechanical engineer of the Klasing Car Brake Company, Joliet, Ill.

◆

A. A. ORTEGA, who has been sales engineer for the Magor Car Corporation, with headquarters at Havana, Cuba, since 1923, has been appointed export sales



A. A. Ortega

manager, with headquarters at New York, to head the export department recently created by the corporation. He was born in Santiago de Cuba, Cuba, on September 1, 1888, was educated at schools in Cuba and at Delaware Academy, Delhi, N. Y., and was graduated with a civil engineering degree from Rensselaer Polytechnic Institute, Troy, N. Y., in 1913. Until 1919 Mr. Ortega was on location and construction work on railroads and highways in Cuba and the Dominion Republic. In the latter year he joined the staff of A. M. Puente & Co., agents at Havana for Magor Car Corporation, and in 1923 went directly with Magor as sales engineer.

◆

R. VOLBRECHT has been appointed to the New York merchandising sales staff of Cutler-Hammer, Inc.

◆

UNITED STATES STEEL CORP. OF DELAWARE.—*G. Cook Kimball,* executive vice-president of the United States Steel Corporation of Delaware, at Chicago, will temporarily make his headquarters at Washington, D. C., effective August 15, in the interest of further co-ordinating United States Steel activities arising from increasing requirements of the national defense program. During his temporary absence from Chicago, *C. H. Rhodes,* vice-president, will take over the activities and duties which have been under Mr. Kimball's direction.

◆

OKADEE CO.-VILOCO RAILWAY EQUIPMENT CO.—*Charles G. Leoarned,* vice-president of the Okadee Company, and the Viloco Railway Equipment Company, Chicago, has also been placed in charge of sales and has been elected vice-president in charge of sales of the Viloco Machine Company, Benton Harbor, Mich., the manufacturing subsidiary, with headquarters in Chicago. *Curtiss W. Ploen,* mechanical engineer, has been elected vice-president in charge of manufacturing and engineering, and *B. B. Rich,* treasurer, has been elected treasurer and comptroller.

◆

SAMUEL M. FELTON, whose appointment as Eastern sales manager of the railroad division of the Edward G. Budd Manufac-



Samuel M. Felton

turing Company was recently announced, was born in Cincinnati, Ohio, in 1893, the son of the late S. M. Felton, who was president of the Great Western from 1909 to 1925, and chairman of the board until his death in 1930. He was graduated from Harvard University in 1916 and in 1917 went overseas with the 13th Engineers, the regiment which operated the Verdun military railways, and later became adjutant in the U. S. Engineering Brigade with the British Third Army, in connection with the operation of trench tramways.

On his return from overseas, Mr. Felton joined the Pure Oil Company, and rose successively through various positions to become general manager of the Eastern division. He was associated with the White Motors Company from 1926 to 1935, when he joined the Budd organization.

Obituary

HERBERT W. WOLFF, senior vice-president in charge of sales, American Car and Foundry Co., with headquarters at New York, died on July 27, at his summer home at Grayling, Mich., at the age of 66, after an illness of a year's duration. Mr. Wolff was born in Hamilton, Ont., on December 27, 1873, and received his early education in the public schools of Detroit, Mich. He began his business career with the Michigan Car Company in Detroit, which company was later consolidated with the Peninsular Car Company under the title Michigan-Peninsular Car Company.

At the time of the organization of the American Car and Foundry Co. in 1899, Mr. Wolff went to St. Louis, Mo., as chief mechanical engineer of the new corporation. In 1912 he was appointed assistant to vice-president and in 1916 was elected vice-president in charge of sales in the Chicago district. During the World War period Mr. Wolff spent a great deal of time in Washington, D. C., working with the United States Railroad Administration and the Military Railways Division of the War Department in co-ordinating industrial facilities. In 1925, Mr. Wolff was elected a director of A.C.F. and in the same year was made executive head of sales of the entire corporation, with office in New York. In 1935 he was appointed senior vice-president of the company, the position he was holding at the time of his death.



Herbert W. Wolff

Personal Mention

General

H. S. KELIN has been appointed mechanical engineer of the Union Railroad, with headquarters at East Pittsburgh, Pa.

F. R. DENNEY, master mechanic of the Texas & Pacific, at Shreveport, La., has been promoted to assistant mechanical superintendent, with headquarters at Dallas, Tex.

HARRY REES, district master mechanic of the Baltimore & Ohio at Cincinnati, Ohio, has been appointed superintendent of motive power of the western lines, with headquarters at Cincinnati. Mr. Rees was born on September 30, 1885, and entered B. & O. service as a machinist at New Castle, Pa., on September 4, 1913. He became foreman on September 1, 1917; assistant master mechanic, on November 16, 1917, and general foreman on March 15, 1919. On May 1, 1920, he became general foreman at Garrett, Ind., and general foreman at New Castle Junction, Pa., on July 1, 1926. On April 15, 1927, he was appointed master mechanic at Akron, Ohio, and became division master mechanic, with headquarters at Akron, on February 1, 1932. On December 1, 1936, Mr. Rees was appointed district master mechanic at Cincinnati.

Master Mechanics and Road Foremen

J. E. FRIEND, master mechanic of the Texas & Pacific at Big Spring, Tex., has been transferred to Fort Worth.

F. L. HALL, superintendent of shops of the Baltimore & Ohio at Ivorydale, Ohio, has recently been appointed master mechanic with headquarters at Cincinnati.

T. L. PREUN, assistant master mechanic of the Philadelphia division of the Pennsylvania, with headquarters at Harrisburg, Pa., has been appointed master mechanic of the Northern division.

WILLIAM C. SMITH, who has been appointed master mechanic of the New York, New Haven & Hartford at New Haven, Conn., as announced in the June issue, was born in New York City on September 22, 1896. He attended high school in New York and in January, 1915, entered the service of the N. Y. N. H. & H. as a machinist helper. From April, 1917, until November, 1919, Mr. Smith served in France with the A. E. F. He returned to the N. Y. N. H. & H. in December, 1919, as a machinist. He served in the mechanical engineering department from January, 1921, until September, 1923, when he was appointed mechanical inspector, supervisor of pit inspection and chief mechanical inspector, respectively. In July, 1939, he was promoted to the position of assistant master mechanic. He was appointed master mechanic in April, 1940.

H. C. VINSANT, master mechanic of the Texas & Pacific at Ft. Worth, Tex., has been transferred to Marshall.

H. J. BURKLEY, master mechanic of the Baltimore & Ohio at Cincinnati, Ohio, has become district master mechanic with the same headquarters.

PAUL THOMAS, assistant master mechanic of the Panhandle division of the Pennsylvania, with headquarters at Mingo Junction, Ohio, has been transferred to the Philadelphia division.

C. H. SPENCE, district motive power inspector of the Baltimore & Ohio at Baltimore, Md., has been promoted to master mechanic with headquarters at Du Bois, Pa.

JOHN E. DAVIS, who retired on July 1 as master mechanic of the Chesapeake & Ohio at Columbus, Ohio, was born in Dover, England, on January 16, 1869. He entered railway service on April 1, 1882, as a messenger in the mechanical department shops of the Grand Trunk, now the Canadian National, at Stratford, Ont. He later served as a machinist apprentice and machinist at Stratford, in April, 1890, moving to Port Huron, Mich., where he became a machinist on the Chicago & Grand Trunk, now the Grand Trunk Western. He became gang foreman on June 1, 1896, and erecting shop foreman on April 1, 1899. He became general foreman of the Baltimore & Ohio at Newark, Ohio, on April 1, 1903, and master mechanic at Garrett, Ind., on January 1, 1904. He went to Hoisington, Kan., on November 1, 1906, as general foreman of the Missouri Pacific, and on August 1, 1907, returned east as general foreman of the Hocking Valley, now the Chesapeake & Ohio, with headquarters at Columbus, Ohio. He was appointed master mechanic at Columbus on October 1, 1910.



John E. Davis

Purchasing and Stores

FRANK STEARNS AUSTIN, assistant purchasing agent of the New York Central, has been appointed purchasing agent, with headquarters as before at New York, succeeding Charles C. Warne, deceased.

Obituary

ALONZO PACK, who was chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, between 1918 and 1935, died at Denver, Col., on August 14, at the age of 76. He entered railroad service as a boilermaker in 1882 and between 1887 and 1893 served as locomotive fireman. Between 1893 and 1911 he was employed as a locomotive engineer. In 1911 he entered the service of the Interstate Commerce Commission bureau as district supervisor. In 1914 he was appointed assistant chief inspector of the bureau. In July, 1918, he was appointed chief inspector. Mr. Pack retired from service on July 31, 1935, and was succeeded by John M. Hall.

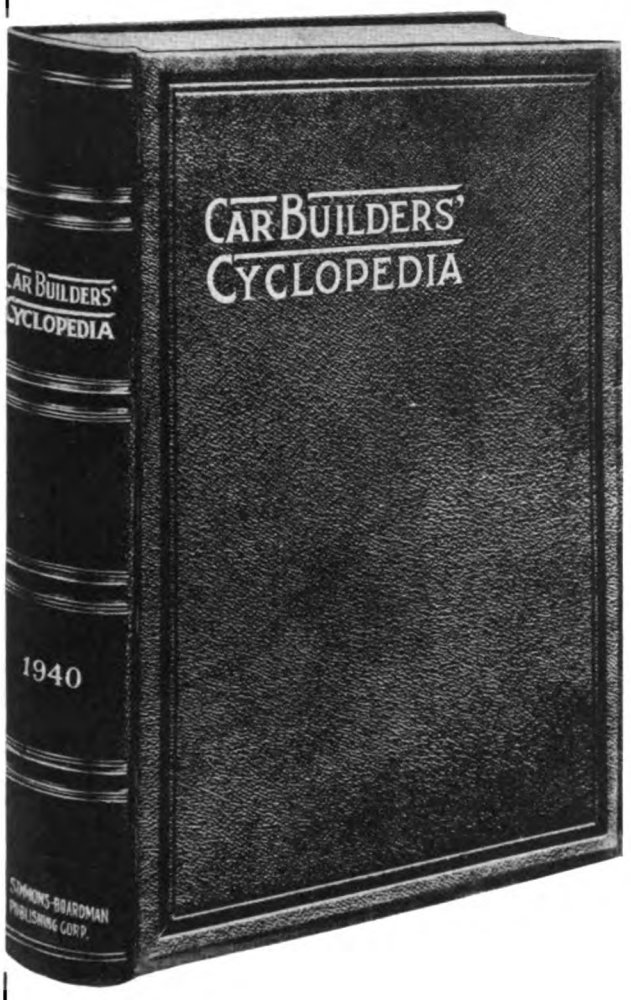
Mr. Pack took over the leadership of the bureau at a time when the condition of motive power of the country was at a low ebb and inspector-personnel depleted by transfer to other activities. He succeeded in building up the organization and expanding its services in line with broadened jurisdiction given to it by amendments to the original Locomotive Inspection Act. In 1932 the bureau reported the best condition of locomotives in service and the lowest accident rate ever recorded.



Alonzo Pack

Mr. Pack was a conference member of the Boiler Code Committee of the American Society of Mechanical Engineers. He was later appointed by the Society to serve on a special committee considering fusion welding. He was also a member of the sub-committee to investigate and report with respect to the practicability of cold flanging of steel boiler plate.

Announcing the 15th Edition of the



CAR BUILDERS' CYCLOPEDIA

Ready October 15th

Completely revised and enlarged to include an expanded Car Shops Section, the Fifteenth Edition of the CAR BUILDERS' CYCLOPEDIA of American Practice will be off the press on or about October 15th. It will contain some 1400 pages, 3000 scale drawings and photographs, measure 9 x 12 x 3 inches, and weighs nine pounds. The price in buckram binding will be $5.00, and in full leather, $7.00, postpaid.

Since 1879 this cyclopedia has been recognized as the standard authority wherever American made rolling stock is in use. It is a one-volume library of up to date technical information on all kinds of railway cars and their equipment, and on maintenance methods and car shop equipment.

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Locomotive:

Alco Diesel Switchers 379
Union Pacific Fourteen-Wheel Tenders 386
Southern Pacific's Method for Semi-Cross-Balancing 389

Car:

Pressed Steel Builds DeLuxe Passenger Coach 382

General:

Coordinated Associations Meet 391
Programs of Coordinated Associations 393
Allied Railway Supply Exhibit 394

Editorials:

S. 2009 Becomes a Law 399
Convention Attendance—Asset or Liability? 399
Shop Employment and National Defense 400
Magnaflux Testing 400
New Books 401

Car Foremen and Inspectors:

Combating Fly Nuisance at C. & N. W. Coach Yards 402
Handling Device for Punching Steel Plate 404
Device for Checking Wheel Concentricity 405
Decisions of Arbitration Cases 406
Air Brake Questions and Answers 406

Backshop and Enginehouse:

How the Small Shop Performs Driving-Box Work 407
Emergency Grip for Air Motor Throttle 409
Instructions for Maintaining Diesel-Electric Equipment 409
Locomotive Boiler Questions and Answers 411

New Car and Loco. Appliances at the Exhibit:

Improved Hulson Grate Design 412
Martin Locomotive Stoker 412
Power Reverse Gear 413
Horizontal Steam-Heat Connection 413
Oil Divider for Lubricating System 413
Berkley Locomotive Stoker 414
Locomotive Staybolt-Hole Bushing 415
Locomotive Spring Band 415
Improved Spee-D Filler Neck 415

New Shop Tools and Equipment

Hydraulic Two-Speed Jack 416
Speed-Variator Equipment 416
Single-Purpose Chaser Grinder 416
Welder Designed for Multiple Operation 417
Triple-Lift Fork Truck 417
Heat-Treating and Forging Furnace 417
Portable Inspection Equipment 418
Tractor Crane with Pneumatic Tires 418
Spotter Connects Tender to Locomotive 418
Self-Contained Portable Arc Welder 418
Miller Features Maneuverability 419
Superfinishing Heads for Engine Lathes 419
Portable Locomotive Crank-Pin Grinder 419
High-Speed Electric Tapper 419
Carboloy Cutting Tools Standardized 420
Direct-Current Arc Welder 420
Versatile Woodworking Machine 420
Hydraulic Piston-Rod Parter 421
Bending Press with All-Welded Frame 421
Respirator Filter Cartridge 422
Automatic Shut-Off Valve 422
Lift Truck Handles Machine Tools 422
Boring, Drilling and Milling Machines 422
Portable Threading Machine 423
Electric Hoist for General Shop Service 423
Lighting Unit Resists Corrosion 423
Double-End Disc Grinder 423
Multiple Cutter Turner 424
Dry-Cutting Cut-Off Machine 424
Machine for Milling Keyways and Splines 424

High Spots in Railway Affairs 425

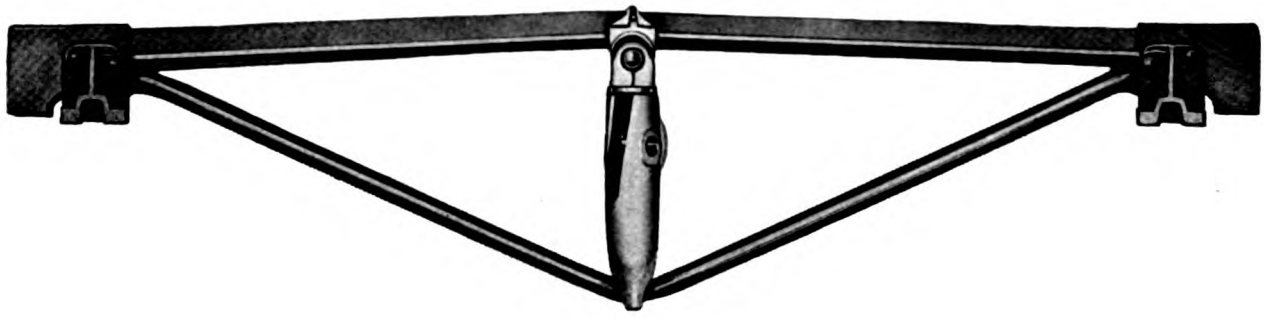
News 426

Index to Advertisers ..... (Adv. Section) 60

UNIT TRUCK

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UNIT Trucks were designed to overcome all of the common failures of the conventional brake rigging.

Unit Truck Side Frames have integral guides protected by wear plates, the top guides being removable to permit interchange with conventional break beam.

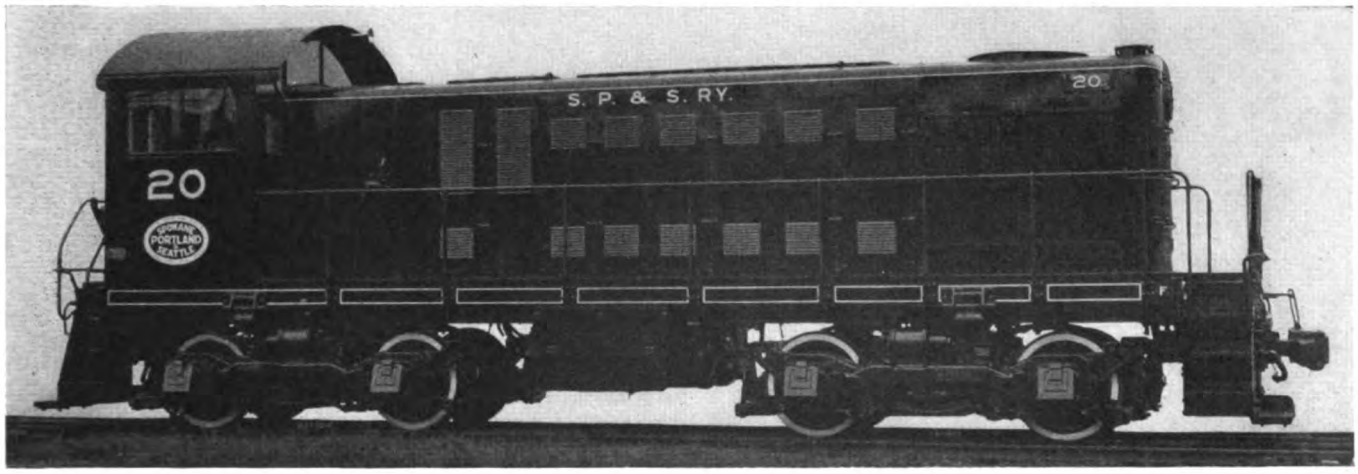
Unit Brake Beams are carried on extended ends protected by wear plates that have 26 square inches of bearing surface, interlocked in the Unit Side Frame and operate on the radial line to the center of the axle resulting in full and even brake shoe wear.

Approved for interchange.

You are cordially invited to visit our exhibit of Unit Trucks, Side Frames, and Unit Brake Beams at spaces No. 1, 2 and 3, Allied Railway Supply Association exhibit, Hotel Sherman, Chicago.

UNIT TRUCK CORPORATION

140 CEDAR STREET NEW YORK, N. Y.



One of the Alco 1,000-hp. Diesel-electric switching locomotives

Improved Visibility and Auxiliaries Drive Feature

Alco Diesel Switchers

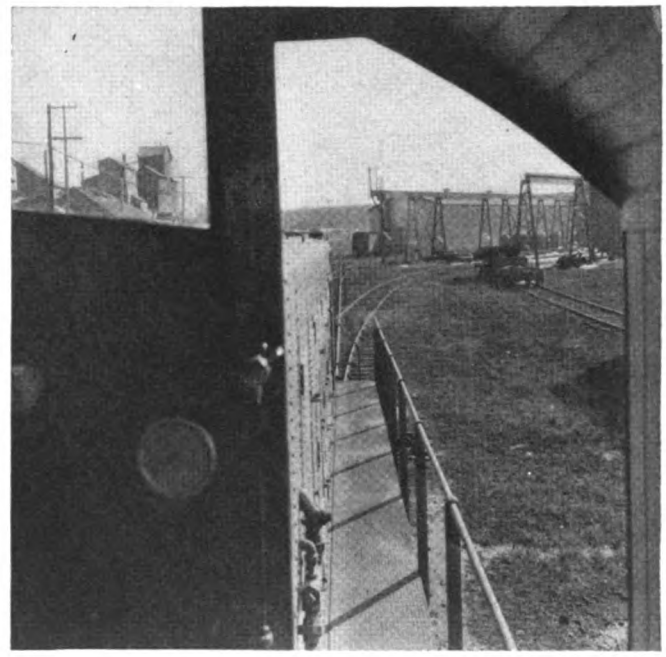
For some time the American Locomotive Company has been making deliveries on 660-hp. and 1,000-hp. switchers of a design in which the visibility has been greatly increased and general appearance improved. Several changes have also been made resulting in simplification of the operation of auxiliaries. The lower engine hood has been made possible by dropping the Diesel engine down into the locomotive underframe. The power plant and auxiliaries are located under the hood with the engine at the center and the radiator at the front. Part of the hood is removable and ventilation is obtained by louvres in hatch doors. In the case of the 1,000-hp. turbo-charged engine air is drawn in through a filter mounted on the hood. On the 660-hp. engine the filter is on the engine.

The locomotives are rated 660 and 1,000 hp., respectively, and all electrical equipment, except the main generators, is identical. In previous designs, the auxiliary generator was mounted on the main generator shaft. In these, all auxiliaries, except the air compressor, are driven by V-belts from sheaves on the main shaft. Formerly the air compressor was motor-driven by power from the auxiliary generator and, in the new locomotives, it is on the main shaft. These changes permit the use of a smaller auxiliary generator and exciter and allow the engines to idle at 250 r.p.m., thereby saving approximately one gallon of fuel oil per hour. The compressor output is 76 cu. ft. per min. at idling speed and 228 cu. ft. per min. at full speed (740 r.p.m.).

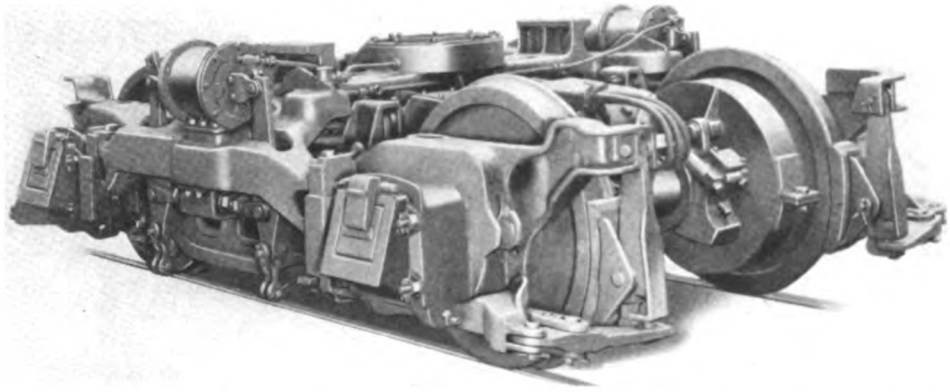
Traction motors have large thermal capacity, those on the 660-hp. unit being rated at 740 amp. and those on the 1,000-hp. unit, 830 amp. The increased rating on the larger locomotive is obtained by increasing the volume of the cooling air; 750 cu. ft. per min. on the smaller and 1,200 cu. ft. per min. on the larger one. Maximum speed restriction is 60 m.p.h.

General Features

The general structure of these locomotives consists of a welded steel underframe on cast-steel swivel trucks, a low narrow hood and an operator's cab at one end. The engine, radiator compartment, generator, auxiliary generator, air compressor and contactors are all located under the hood. The engine is in the center section, with the radiator compartment at the front.



Maximum visibility is obtained with the low, narrow hood



The trucks are equipped with clasp brakes and are reversible under the locomotive to equalize tire wear

The windows in the cab are exceptionally large and there is a very narrow section between the windows. Visibility is further improved by an elevated operator's seat. The cab is heated by an automotive type of water heater.

The Diesel Engines

The 600- and 1,000-hp. Diesel engines are alike except for the addition of a turbo-charger * in the latter type. The increased amount of air supplied by the turbo-charger permits more fuel to be burned per stroke and acts as dilutent, with the result that the full-load exhaust temperature of the turbo-charged (Buchi system) 1,000-hp. engine is only 800 deg. F., while that of the 660-hp. engine is 895 deg. F.

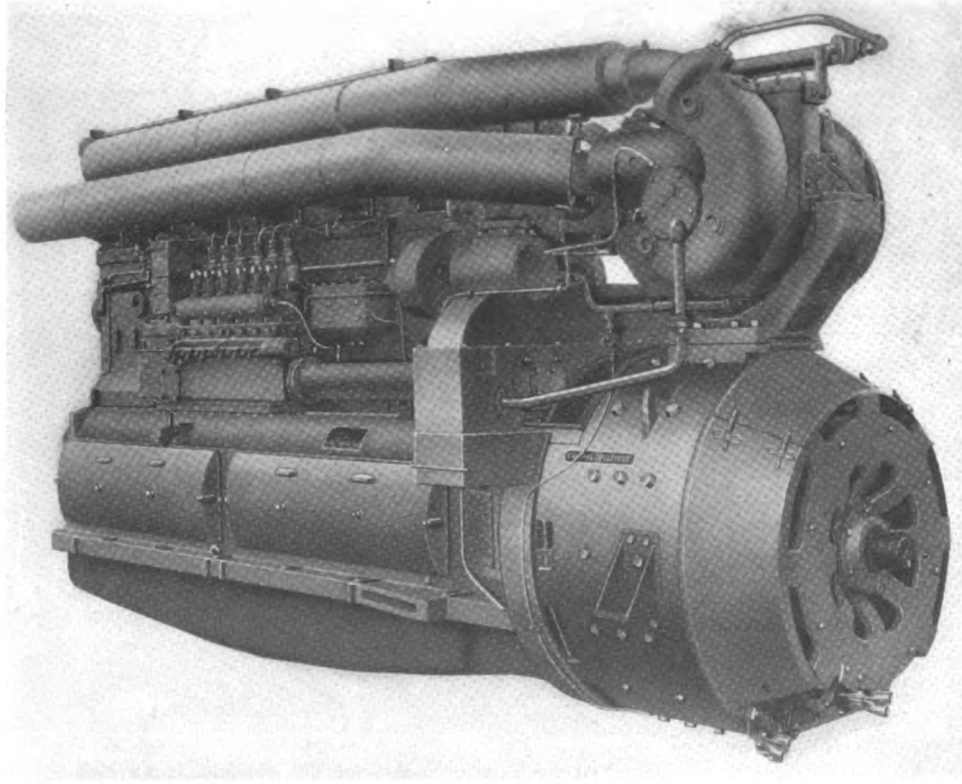
The water- and oil-cooling radiators are of the sectional core type. The radiator fans are V-belt-driven from the engine and shutters are applied outside of the radiators and are operated by a control in the cab. To maintain a nearly constant load on the radiator fan, by-pass shutters are located inside the radiator compartment. They are so arranged that a corresponding graduated movement of the by-pass shutters occurs automatically with a movement of the outside shutters. When the outside shutters are closed, the by-pass shutters are open, and vice versa. This allows complete control of the degree of cooling desired.

Electrical Equipment

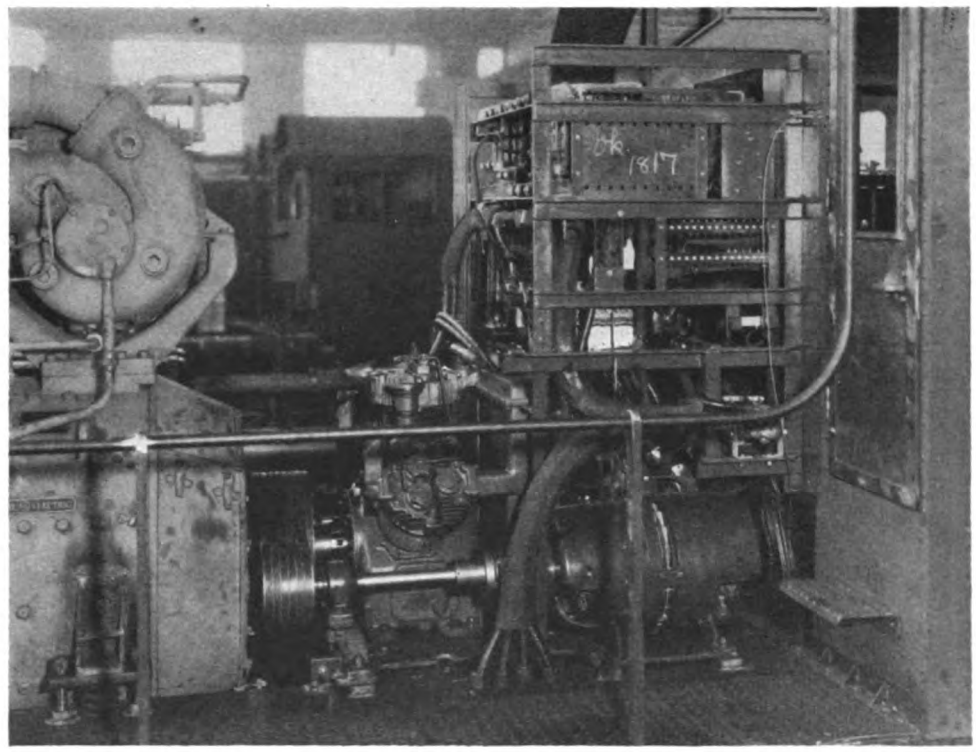
The electrical equipment is built entirely by the General Electric Company. It includes the main traction generator, a belt-driven exciter auxiliary generator, 4 GE-731 series traction motors and complete Type P control equipment.

The main generator is supported by the engine frame and two spring-loaded feet attached to the generator frame. This construction insures alinement between the engine and the generator armature. A single self-alining roller bearing is used at the outboard end of the armature shaft. The auxiliary set consists of a split-pole exciter which furnishes excitation to the main generator and an auxiliary generator which supplies power for the

* A detailed description of the Alco (Buchi system) turbo-charger appeared in an article in the August, 1937, issue of *Railway Mechanical Engineer*, page 339. The results from this system of supercharging were summarized in the August, 1938, issue, page 297.



The Alco turbo-charged 1,000-hp. Diesel engine

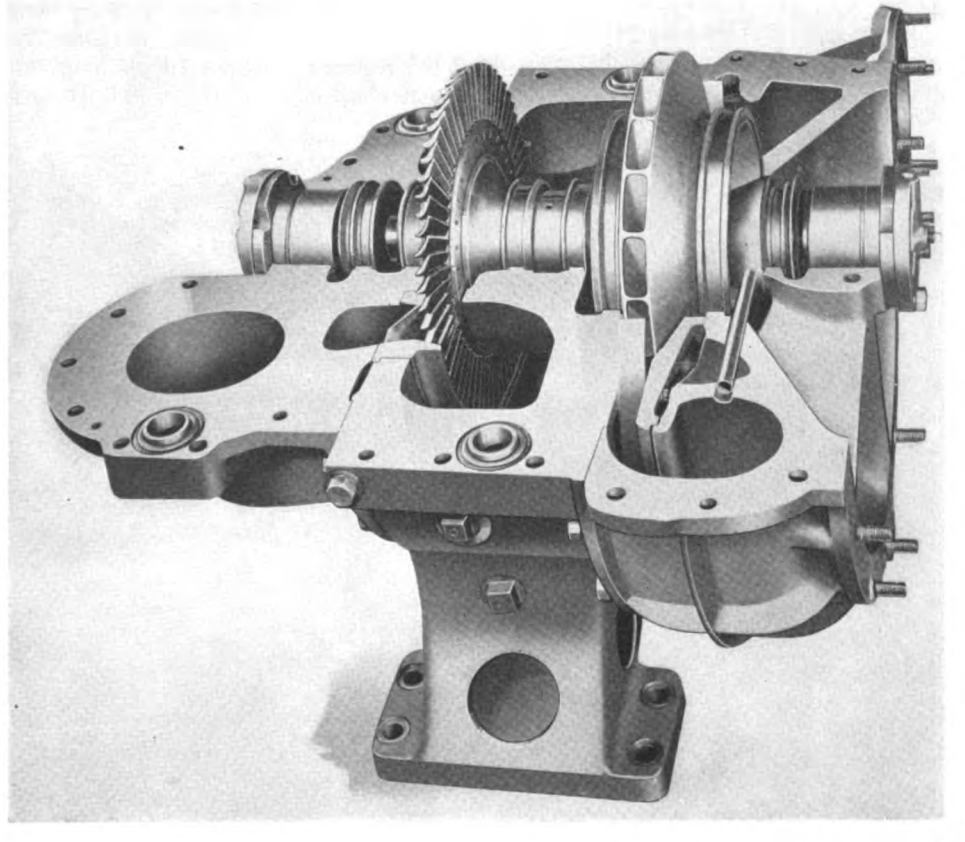


The compressor and exciter are at the rear of the engine and are driven by V-belts

control circuits, the electrically operated auxiliaries and for charging a 32-cell battery. The armatures of the two machines are on the same shaft. The main generator furnished power for the four direct-current commutating-pole traction motors which are permanently connected two in series for series and series-parallel operation. These motors are supported in the locomotive truck by sleeve-type axle bearings and spring-nose suspension from the truck frame. The motor armature bearings are the roller type. The armature shaft has ample rigidity and is so installed that it can be removed without disturbing the windings or commutator. The motor frame is an integral steel casting and has large openings for inspecting brushes.

The Type P single-end, single-unit control functions with a minimum of attention from the engine operator. Power supplied by the engine is applied by means of a throttle lever on the control stand at the engineer's position. The initial movement of this throttle closes con-

(Continued on page 385)



Alco (Buchi System) turbo-charger with the top casing removed



De Luxe passenger coach now on exhibit at the New York World's Fair

Pressed Steel Builds

DeLuxe Passenger Coach

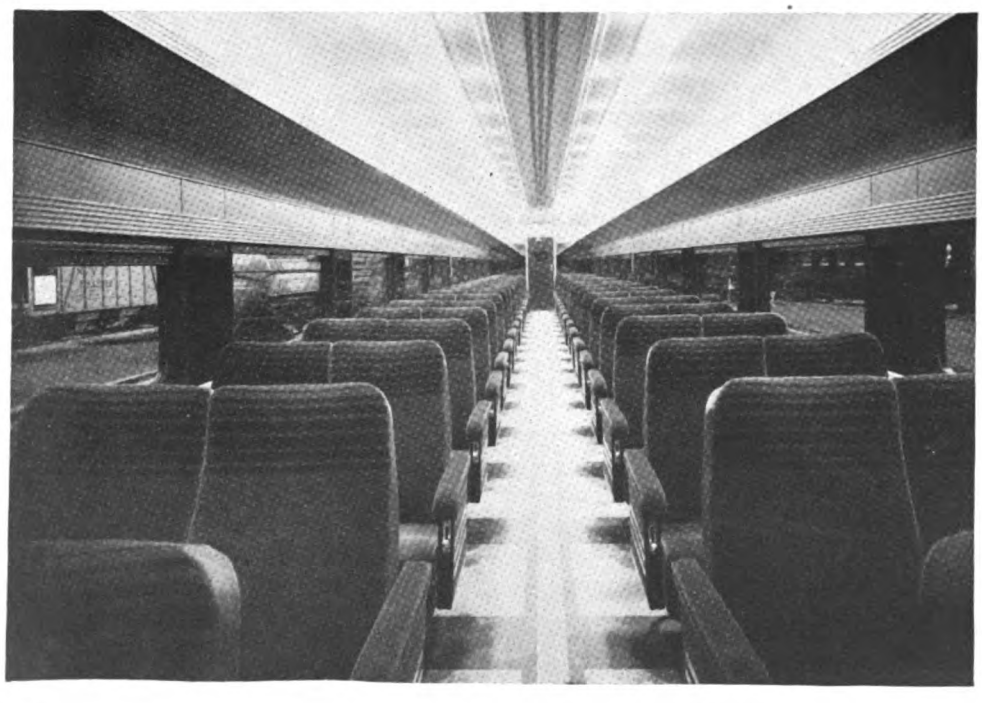
Richly upholstered seats and mirror walls are the distinctive factors in the achievement of an unusual interior effect—Body construction of USS Cor-Ten steel

THE Pressed Steel Car Company has developed a deluxe passenger coach, now on exhibit at the New York World's Fair, in which several innovations of design and appointments combine to produce an unusually pleasing and attractive result. The interior appointments were designed in collaboration with Lurelle Guild, New York.

In designing this car a partially streamlined effect was obtained by making the exterior surfaces as smooth as possible. The car is built of Cor-Ten steel and while it is generally of riveted construction, the center sills are welded to a steel buffer casting. The car has been designed to meet the present A. A. R. requirements as to strength. It more than met the required longitudinal compression-load test of not more than one-half to three quarters inch vertical deflection with 800,000 lb. end load. It was subjected to 926,000 lb. with a vertical deflection of only 0.49 in. with no permanent set after the release of the pressure.

The Car Structure

The center sills consist of rolled A. A. R. Z-bar sections with a continuous weld in the center. The center sill is lower than usual, bringing it more in line with the buffing forces and resulting in a stronger structure. The bolster diaphragms, crossbearers, etc., are of pressed pan shapes. The side posts are pressed U-shapes with rolled-section side sills and side plates. The belt rail is covered with a moulding to conceal the rivets. The floor consists of Keystone flooring with cork base cemented thereto, on top of which Linotile flooring is applied. This floor is supported by longitudinal continuous steel floor stringers which, in turn, are supported by the cross members



Interior of the Pressed Steel coach photographed by its own illumination



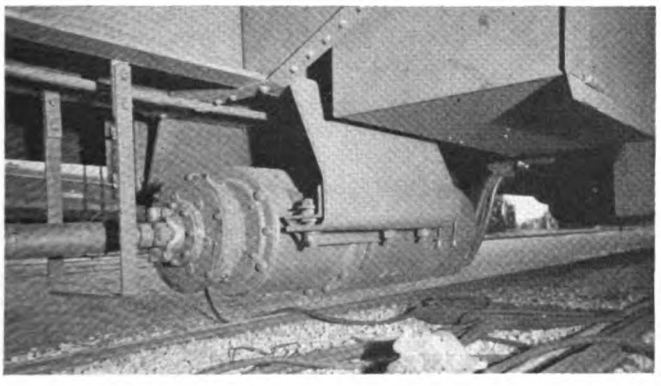
The seats are spacious and upholstery on the arm rests and ends adds richness to the appearance of the car

of the underframe. A false floor is provided below the floor stringers and the space between the false floor and the Keystone floor is insulated. The vestibule floor is of Alcoa tread plates.

The roof is of the turtle-back type. The carlines supporting the roof sheets are partly of channel shape and partly of Z-bar pressed shape. The roof sheets are riveted to the carlines and the lap joints are made watertight by proper grade of Alumilastic cement instead of welding.

The car has a platform on one end, with O. M. Edwards combination folding steps and trap door. The other end is blind construction. At this end are located the two saloons and necessary compartments for the electric equipment and air-conditioning equipment. The ends are not at right angles to the longitudinal center line of the car, as in many coaches built today, but are sloped in order to provide necessary clearance should it be desirable to install outside folding diaphragms instead of the flexible rubber-type diaphragms now frequently used. The car is now equipped only with inside diaphragms, but provision has been made for the application of an outside diaphragm, which, of course, would necessitate a different type of face plate.

The car is well insulated in the roof, side, ends, and floors, and also provided with necessary rubber cushions between the truck and body in order to arrest sound and vibration traveling from the truck to the body of the car.



The Safety Genemotor is suspended under the center sills

Interior Finish and Decoration

The inside finish is unusual in design. The distance from the car floor to top of the window sill is about 4 in. higher than usual in car construction in order to prevent passengers when traveling at high speed from looking down at the adjoining track. The greater width of the sash gives the passenger an exceptionally unobstructed view of the passing scenery.

The sash, consisting of two panels of glass, of which the inside is safety glass, are permanently fixed. The sash is in two parts. The part which holds the glass can be easily removed from the outside for replacement of glass in case of breakage. The inside of the window opening is covered with gun-metal-finish mouldings both for the window sill as well as the curtain guides. The shape of the window sill is such as to prevent passengers from using it as a shelf, thereby protecting the finish.

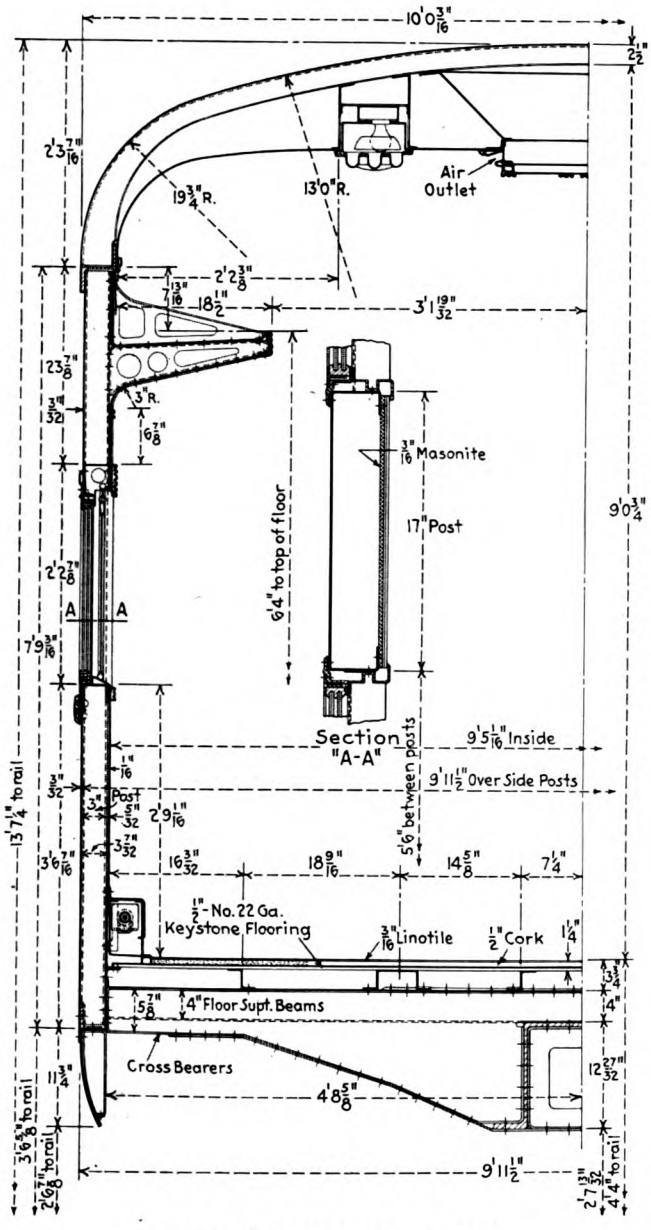
The curtain material was especially woven in order to have a color scheme to match the interior finish of the car. The curtains are equipped with cable fixtures and especially designed gun-metal-finish aluminum apron. This apron will prevent passengers from harming and handling the curtain material and the cable fixtures allow the passengers to open and close the curtain from any position. This is particularly desirable, since the width of the glass covers two seats.

The baggage rack is bone white, edged with aluminum, of the solid continuous type with the top covered with fluted aluminum sheets to allow easy cleaning. Brackets at intervals prevent shifting of baggage. There are no lights in the rack.

All mouldings are of extruded aluminum with Alumilite finish.

All posts from window sill to bottom of window header, as well as the ends of the car, both at the platform end and the saloon end are covered with gun-metal mirrors. The mirrors are cemented to a backing which will prevent glass from shattering in case of breakage.

The heater pipes are covered with perforated polished stainless steel.



A section of the car at the cross bearer

The seat fabric is mohair striped at the top to make the seats appear wider. The window shades pick up the color of the car—aluminum and green, in lateral stripes. The composition floor covering of black and cream tile is designed and styled so that the black marbleized pattern comes at intervals coinciding with the seats. A touch of aluminum color is used between the windows and the baggage rack and in the vestibule. Beneath the windows, as well as on the doors, a supporting substantial color is used—the same soft green-blue of the upholstery. The ceiling is painted bone white.

General Weights and Dimensions of Pressed Steel Passenger Car

Length over buffer face plate, ft.-in.	84- 8
Truck centers ft.-in.	59- 4
Length inside of passenger compartment, ft.-in.	71- 4
Seating capacity	80
Width over side sheets, ft.-in.	9-11 11/16
Height from rail to top of roof, ft.-in.	13- 7 1/4
Distance from rail to skirting, ft.-in.	2- 6 7/8
Distance from rail to top of floor, ft.-in.	4- 4
Lightweight, lb.	111,200

The exterior of the car is finished in matched warm gray tones, the roof of a darker color with bands between the windows of the same tone. The side walls are striped with aluminum, and at top and bottom of the windows are repeated notes in aluminum stripes.

Seating Arrangement

All seats are of the revolving, reclining, sliding-cushion type, furnished by the Coach & Car Equipment Corporation. They have double tilting footrests which add to the comfort and do not obstruct the passage between seats. Except for a few stainless-steel mouldings below the arm rest as a matter of protection of the covering, no metal is visible. The seats are covered with an especially woven Chase upholstery material of a blue-green color, the arm rest and ends all are covered with the same upholstery material which produces a rich looking seat. The seats have spring backs, whereas the seat cushions are rubber.

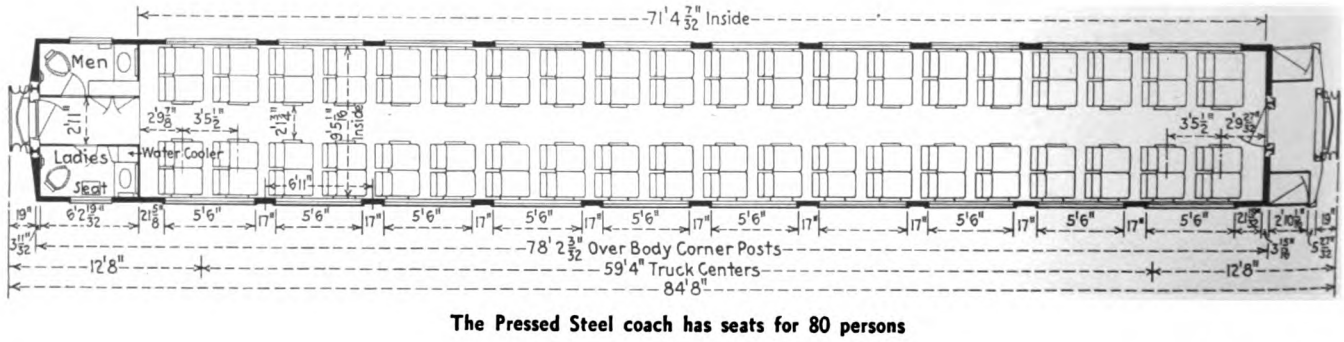
Lighting and Air Conditioning

The lighting system consists of lensed glassware mounted one over each passenger seat in two rows down the ceiling. A continuous trough is imbedded in the light fixture above the ceiling and this trough is covered by plastic ribs which appear to be a continuation of the glass design. When lighted, the plastic ribs take on a glow from the light thrown back by the continuous trough imbedded in the ceiling. The effect of a continuous lighting system is, therefore, accomplished although the light sources are only 40 watts and located directly above the lenses. Readings taken on a 45-deg. plane 30 in. above the floor at the center of each seat at rated voltage show a variation of 8 to 10 foot-candles.

Night lighting is furnished by blue bulbs in the trough located at points between fixtures. The magnifying lenses over each seat are so focused as to prevent glare on the passenger who looks forward or across the aisle and at the same time to prevent shadow on his reading matter.

The glassware and plastics are all hinged with sealed edges to prevent dust infiltration.

Power for light and air conditioning is obtained from a 20-kw. Genemotor made by the Safety Car Heating & Lighting Company, New Haven, Conn. It is driven from the car axle by a Super Gear drive supplied by the



The Pressed Steel coach has seats for 80 persons

Super Gear Corp., Chicago. The Genemotor may also be operated from 3-phase, 220-volt standby power through a Pyle-National, four-pole receptacle located at one side under the car. When the Genemotor is not operated or is running at low speeds, power is taken from a Gould KALD-35-R, 32-volt storage battery. It has an eight-hour rating of 1,000 amp. hr. and is mounted in two battery boxes on opposite sides under the car. Pyle-National receptacles are available on both sides of the car for receiving d. c. charging current from yard or station outlets.

Air-conditioning equipment was supplied by the Frigidaire Division, General Motors Corp., Dayton, Ohio, and is equipped with the correlative control of the Vapor Car Heating Co., Chicago. This company also supplied the steam-heating equipment. Exhaust fans were made by the Diehl Manufacturing Company.

The lights in the car are arranged on eight circuits. Four circuits feed alternate lights on each side of the car, two others supply the night lights, and the remaining two are used for washroom and passenger lights and vestibule lights at opposite ends of the car.

The car is equipped with General Steel Castings four-wheel trucks with bolster stabilizers and shock absorbers. Simplex Unit-Cylinder clasp brakes, with two brake cylinders, are mounted on each truck. The wheels are fitted with ASF roller-bearing units. Center pins are of the Miner locking type.

These cars are equipped with Westinghouse Air Brake Company's HSC brake with D-22-A passenger control valve. The coupler equipment is the National tight-lock type, and the draft gears, Miner A-5-XB. Barco steam train-line connectors are applied.

Principal Weights and Dimensions of Alco Diesel-Electric Switching Locomotives

	660 hp.	1,000 hp.
Length overall, ft.-in.	44- 5¾	45- 5¾
Width overall, ft.-in.	10- 0	10- 0
Height from rail, (max.) ft.-in.	14- 4	14- 6
Wheel base, rigid, ft.-in.	8- 0	8- 0
Wheel base, total, ft.-in.	30- 0	30- 6
Truck wheels, diameter, in.	40	40
Total locomotive weight, lb.	199,000	230,000
Weight on drivers, lb.	199,000	230,000
Starting tractive force, lb.	59,700	69,000
Maximum speed, m.p.h.	60	60
Minimum radius curvature, locomotive alone, ft.	50	50

Alco Diesel Switchers

(*Continued from page 381*)

tacts which operate the main circuit and field contactors. The traction-motor reverser and line contactors are pneumatically operated and the remaining contactors magnetically operated.

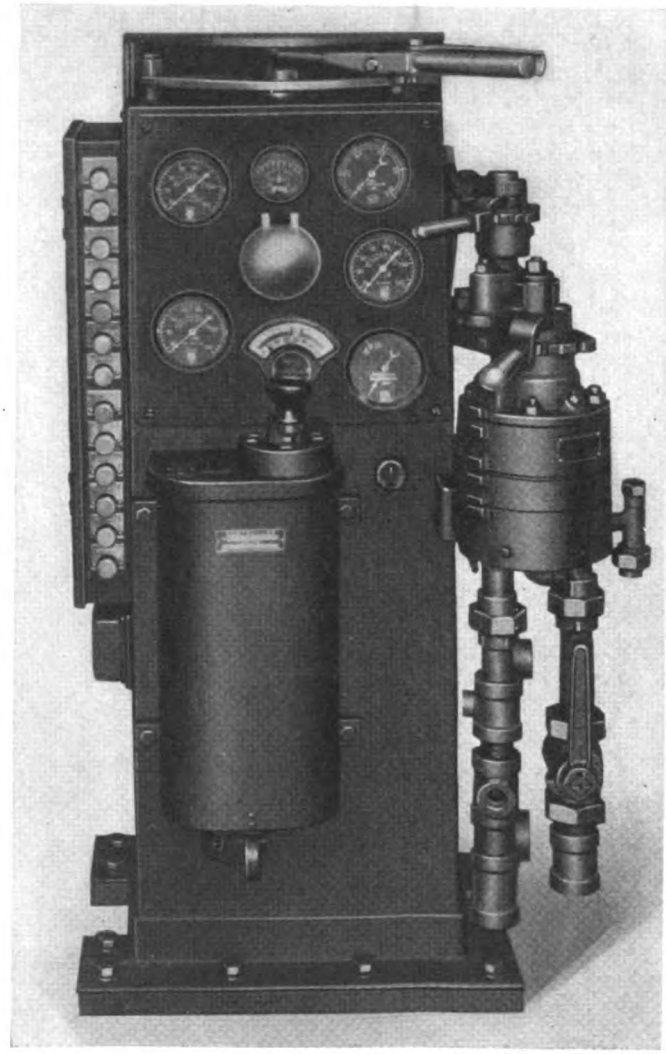
The traction motors are arranged to operate in series and series-parallel, and there are also connections for shunted-field operation. The motor connections are changed automatically from series to series-parallel and from series-parallel full-field to shunt-field operation.

Automatic transfers are provided not only at rated engine speed but over the entire operating range of the engine. The relay which effects this automatic control materially increases the engine utilization during partial control and as a result more rapid acceleration and higher average and top locomotive speeds are obtained when operated at reduced engine speeds. A current relay and indicating light give visible warning when the locomotive is operating below the proper speed range with the motors in the series-parallel connection. A wheel slipping relay with a buzzer also operates to warn the engineer when any pair of wheels slips.

The master controller is used to select the motor combination and the direction of movement of the locomotive. This controller has three forward, one off and three reverse positions. When the handle is placed in the third operating position before opening the throttle, the motor connections will then be changed automatically from series to series-parallel and field-shunting without attention on the part of the operator. If desired, the handle can be placed in the first forward or first reverse position so that it will maintain series connections of the motors. A multi-button switch at the operating stations gives the engineer control of the fuel pump, engine starting and the several lighting circuits.

The trucks are interchangeable and reversible, to equalize flange wear. The only difference between the trucks on the two locomotives is that heavier springs are used on the 1,000-hp. unit which is about 30,000 lb. heavier than the 660-hp. design. Clasp brakes are applied with a large bearing area and those on one truck may be hand-operated. The gear ratios on both locomotives are $^{16}/_{75}$ and the wheel diameters are 40 in. The maximum tractive force is 29,200 lb. for the 660-hp. locomotive and 34,000 lb. for the 1,000-hp. unit.

The Westinghouse air compressor is driven directly from the main shaft. It is a two-stage, air-cooled compressor with a capacity of 228 cu. ft. per min. at 740 r.p.m. The air brakes are Type 14-EL.



All controls are mounted on a stand convenient to the operator

Union Pacific

Fourteen-Wheel Tenders

Large capacity for length and weight, improved stability and easy riding properties are features of tender built on a combined truck and pedestal cast-steel bed

EXPERIENCE during recent years has shown that important operating economies result when locomotives are provided with tenders having increased coal and water capacities. Enginehouse stalls and turntables limit the total length of locomotive and tender and modern power requirements have increased the sizes of the locomotive proper to such an extent that the length of the tender is generally restricted.

The clearances of the right-of-way place a definite limit on width, and the height is governed by water and coal-loading facilities. This too often results in a short tender wheelbase and a high center of gravity.

The use of two swiveling trucks, either six or eight-wheel, and providing for the required end clearances, in most cases brings about comparatively short truck centers and necessitates liberal side-bearing clearances. These factors tend to produce instability, considerable surge in the cistern, high spring maintenance and low wheel mileage between turnings.

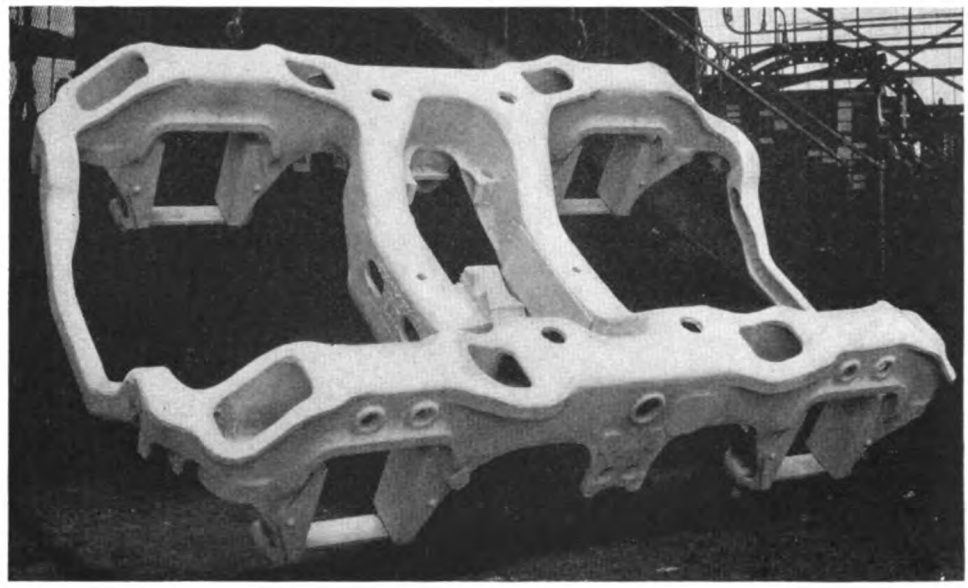
Much thought has been directed to a solution of these problems, the demand for more coal and water, higher speeds and increased braking power, indicating that not only are more wheels required but larger diameter wheels as well, and generally improved construction are essential. One important improvement, commonly used for a number of years on American railroads, is the inclusion of the bottom of the tender cistern as an integral part of the cast-steel water-bottom tender frame, in this way utilizing the depth of the frame for water storage.

The decision of the Union Pacific to build large tenders having capacities for 23,500 gal. of water and 25 tons of coal for long runs and high-speed operation necessitated departures from conventional American tender designs. The increased capacities were to be obtained within an established total wheelbase larger diameter wheels, lighter rail loads per pair of wheels, more uniform weight distribution, and increased wheel mileage, with high-speed braking conditions. This new-type tender was also to incorporate improved riding qualities, better stability and lower track stresses than existing types of tenders which, up to this time on the Union Pacific, had utilized conventional six-wheel trucks on all large tenders.

The engineers of the Research and Mechanical Standards department of the Union Pacific, collaborating with engineers of the General Steel Castings Corporation, after a number of studies had been developed, decided upon a construction with a wheel arrangement similar to a 4-10-0 type locomotive with 42-in. diameter wheels throughout. A four-wheel swiveling, laterally-controlled,



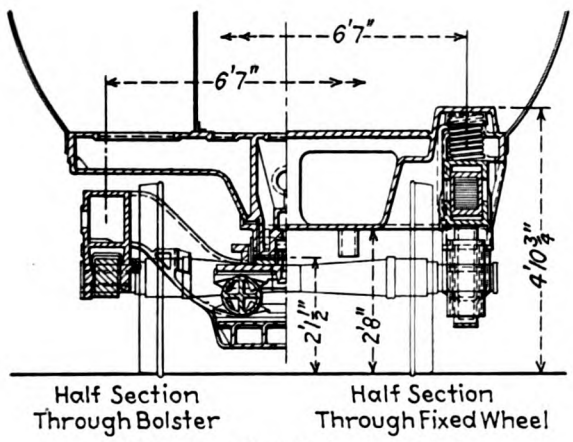
Union Pacific 14-wheel locomotive tender, equipped with Commonwealth cast-steel tender bed having integral pedestals for the five rear pairs of wheels



Commonwealth cast - steel front tender - truck frame arranged for renewable centering device used with tender bed

outside-bearing guiding truck was located at the forward end. Rearward of this were placed five pairs of wheels guided in pedestals cast integral with the water-botton tender frame, or as now designated, the tender bed.

The leading truck is the General Steel Castings Corporation four-wheel equalized type with a roller centering device designed for 17 per cent initial and constant resistance.



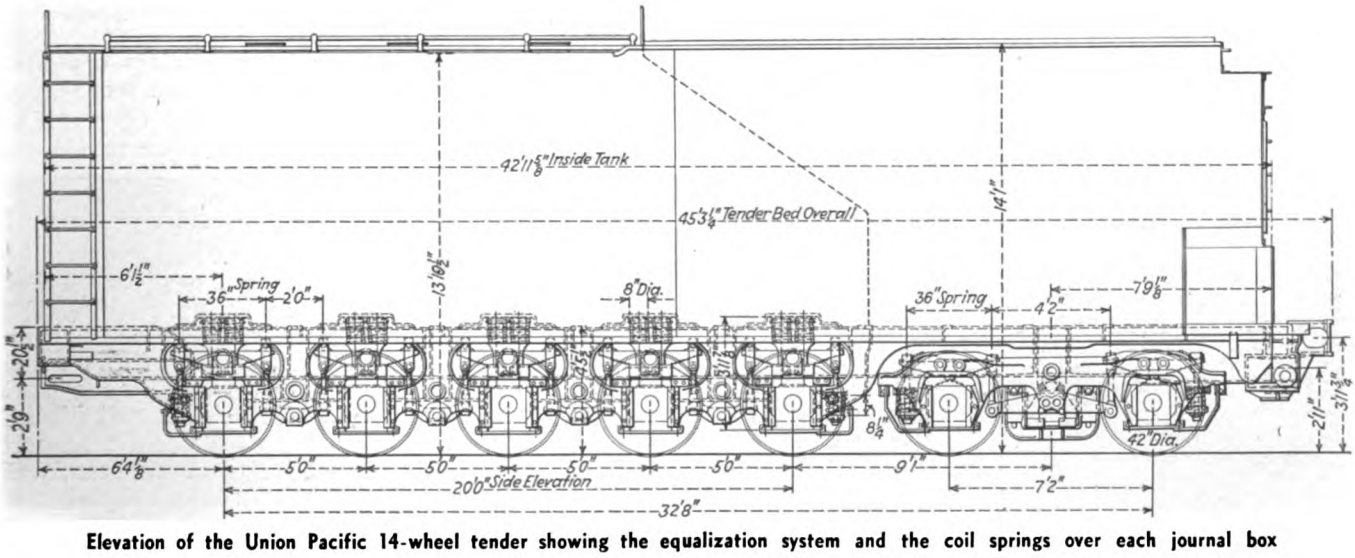
Half sections through the tender bed

The five pairs of pedestal wheels are equalized together, with one semi-elliptic spring and two coil springs over each of the roller-bearing journal boxes. The front and back end of each equalizing system is attached to the frame through cushioning coil springs. Between each box and the semi-elliptic spring saddle is a centering device to resist lateral movement.

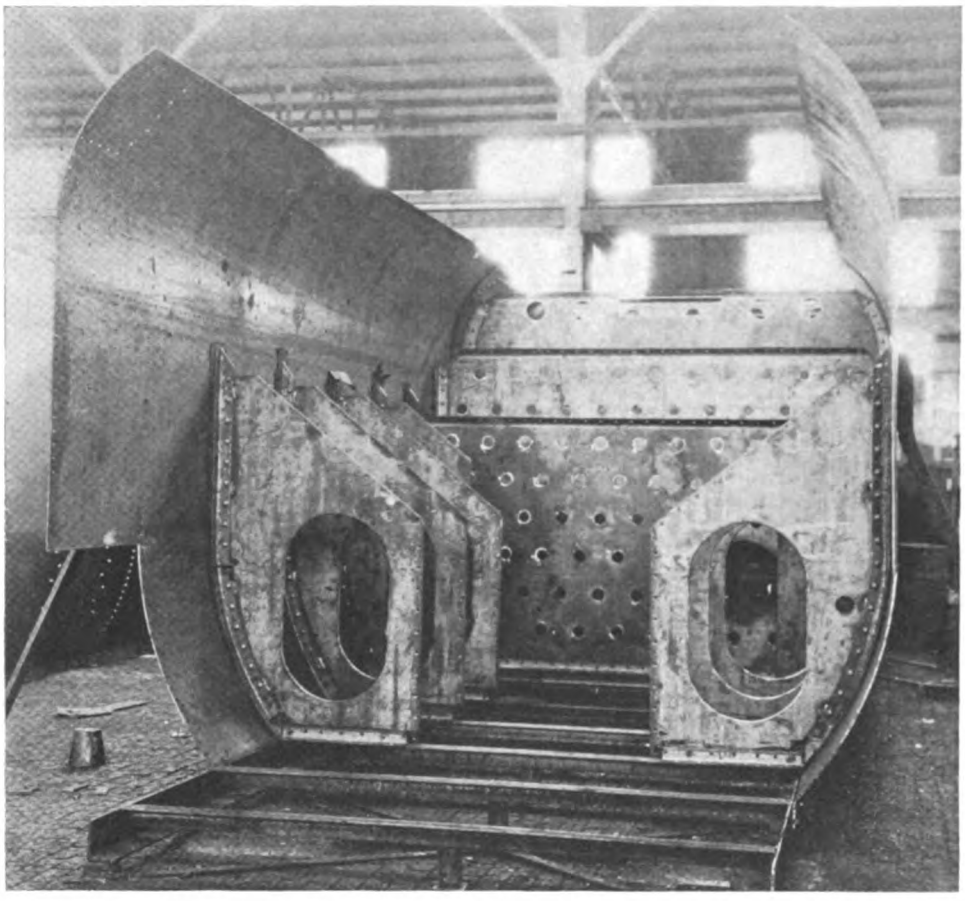
With spring rigging equalization, a three-point loading is obtained, one point being at the swiveling truck center plate and the other two points in the pedestal group equalization assembly.

Each pedestal of the fixed group has hardened spring-steel pedestal liners made up of two plates between which is bonded one-half inch of rubber, arranged to permit ½ in. of lateral movement of the box. Additional lateral is provided between the box and pedestal liner, permitting a total lateral movement of 1¼ in. on each side of axles Nos. 3, 4, 5 and 6, and ¾ in. on each side of axle No. 7.

This novel tender construction necessitated the development of suitable brake rigging. The American Steel Foundries, in collaboration with engineers of the Research and Mechanical Standards department of the Union Pacific and of the General Steel Castings Corpora-



Elevation of the Union Pacific 14-wheel tender showing the equalization system and the coil springs over each journal box



Interior of the tender tank showing general construction and arrangement of the splash plates

tion, developed a Simplex unit-cylinder clasp-type brake application for the lead truck employing two brake cylinders, one mounted on each side of the truck frame.

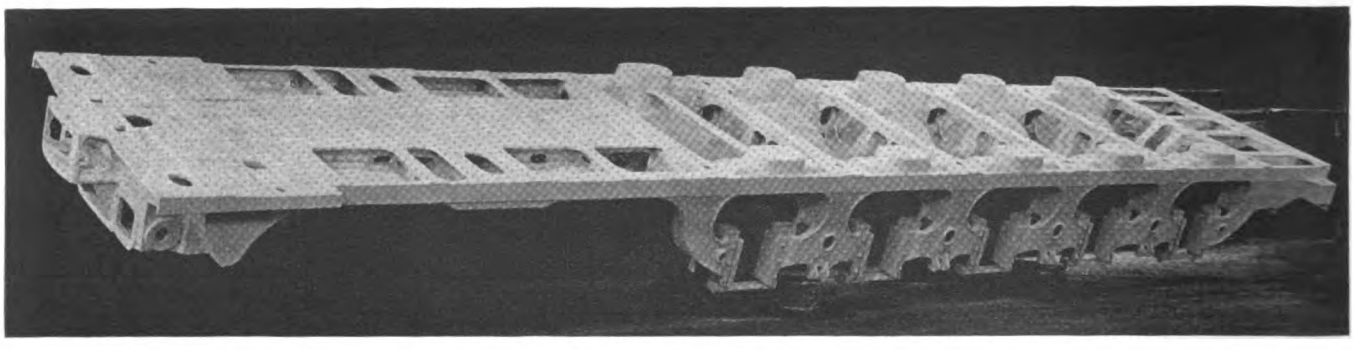
For the 10-wheel fixed group, clasp brakes were likewise used, each pair of wheels being braked by one brake cylinder suspended from the underside of the tender bed. All brake-rigging pins are fitted with elastic stop nuts and anti-rattling devices where practical. Two single brake shoes 15 in. long are applied to each wheel, reducing brake-shoe pressure per square inch. Large bearings with soft grease lubrication are utilized throughout the trucks.

The tender-bed casting has large openings opposite the semi-elliptic springs, equalizer pins and foundation

(*Continued on page 390*)

Partial List of Equipment on the Union Pacific 14-Wheel Tenders

Cast-steel tender bed and front truck frame	General Steel Castings Corporation, Granite City, Ill.
Steel forgings	American Locomotive Company, New York
Roller bearings (10)	Timken Roller Bearing Company, Canton, Ohio
(5)	SKF Industries, Philadelphia, Pa.
Simplex unit-cylinder clasp brakes	American Steel Foundries, Chicago
Air brakes	New York Air Brake Company, New York
Brake shoes	American Brake Shoe & Foundry Co., New York
Stoker	Standard Stoker Co., Inc., New York
Tender wheels and tank plate	Bethlehem Steel Company, Bethlehem, Pa.
	Carnegie-Illinois Steel Corporation, Pittsburgh, Pa.
Coupler	National Malleable & Steel Castings, Co., Cleveland, Ohio
A5XB draft gear	W. H. Miner, Inc., Chicago
Radial buffer and flexible steam heat connection	Franklin Railway Supply Co., Inc., New York
Stoker engine steam-line flexible connections	Barco Manufacturing Company, Chicago
Rubber pedestal liners and tank hose	U. S. Rubber Company, New York
Wovenstone steam-heat pipe insulation	Union Asbestos & Rubber Co., Chicago
Metallic steam conduit	Vapor Car Heating Co., Inc., Chicago
Tank valves	Crane Company, Chicago



The Commonwealth cast-steel tender bed showing details of the integral pedestal arrangement for the five rear pairs of wheels

Southern Pacific's Method for

Semi-Cross-Balancing

By Morris P. Taylor*

A substantial reduction in the overbalance of the main driving wheels is obtained by this method in which the cross forces acting on the other driving wheels are considered

IN counterbalancing locomotives in the United States, it is not customary to cross-balance driving wheels other than the main and sometimes the intermediate wheels, as it is usually considered that the cross-balance effects on these wheels are not large enough to be important. However, when these wheels are counterbalanced by the static method and the balance for the reciprocating parts is divided equally among them, it will be found that if the dynamic forces in each wheel are calculated allowing for the couples set up by the out-of-plane actions of the forces, the true dynamic augment is considerably less than when calculated by the static method.

The diagram in Fig. 1 shows the rail-loading conditions on a pair of intermediate wheels which are balanced statically with a nominal overbalance of 240 lb. In order to make the calculations complete, all static and dynamic forces on the rail have been taken into account so that the actual rail loads on both wheels have been calculated. The actual force causing dynamic augment is found to be 180 lb. opposite the pin, and 60 lb. at 90 deg. from the pin, or a resultant force of 190 lb. Thus, if a locomotive has the main driving wheels cross-counterbalanced correctly for the revolving forces with the remaining wheels balanced statically and the overbalance for the reciprocating parts distributed equally among all the wheels, the actual dynamic augment due to the overbalance will be the greatest on the main wheels. The following table shows typical values for a locomotive with eight driving wheels:

Coupled Wheels Statically Balanced

Wheel	Front	Main	Intermediate	Back
Overbalance, lb.	180	180	180	180
Forces producing dynamic augment, lb.:				
Opposite crank pin	159	180	120	159
Cross force	21	0	60	21
Resultant force	160.4	180	134.2	160.4

Total reciprocating balance per locomotive—720 lb.

The resultant forces are not equal, being greatest on the main wheels. This is just the opposite of the correct condition since the main wheels are subjected to additional forces by the steam action and the inertia of the reciprocating parts. Also, the main wheel assembly has the greatest unsprung weight, so its natural frequency of vibration is the lowest.

Assuming that 720 lb. of reciprocating balance per locomotive are necessary to insure smooth riding in this particular case and that it is desired to keep within the allowable limit of 180-lb. force causing dynamic augment per wheel, it is possible to use the following amounts of apparent overbalance in the front, intermediate and back wheels:

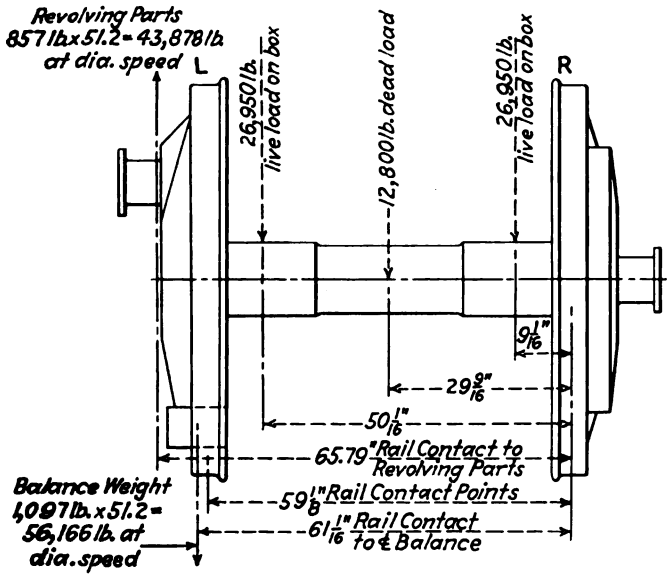
Overbalance, lb.:

Front and back $= \sqrt{(180)^2 - (21)^2} + 21 = 199$

Intermediate $= \sqrt{(180)^2 - (60)^2} + 60 = 230$

The derivation of this formula and the calculation of the maximum apparent overbalance to be used in the intermediate wheels are shown in Figs. 2. There is, of course, a small theoretical error in this derivation because the cross force, due to out-of-plane action, is computed by the usual method, neglecting the very small cross effect caused by the fact the overbalance is not in line with the point of rail contact. However, this error is within the shop limits of balancing, and has been neglected.

Now, if it is desired to keep within the limit of 720-lb. balance in the locomotive for the balance of the reciprocating parts, the main wheels need only have an overbalance of 720 — (199 + 199 + 230), or 92 lb. Thus,



Moments About Right Rail		Moments About Left Rail	
+26,950 × 9.06 =	+ 244,200	+43,878 × 6.67 =	+ 292,600
+12,800 × 29.56 =	+ 378,400	−56,166 × 1.96 =	− 110,100
+26,950 × 50.06 =	+1,349,100	+26,950 × 9.06 =	+ 244,200
+56,166 × 61.06 =	+3,430,000	+12,800 × 29.56 =	+ 378,400
−43,878 × 65.79 =	−2,886,700	+26,950 × 50.06 =	+1,349,000
	2,515,000		2,154,100
2,515,000 ÷ 59.12 =	42,540 lb.	2,154,100 ÷ 59.12 =	36,430 lb.
Force on left rail =	42,540 lb.	Force on right rail =	36,430 lb.
Static load =	33,350 lb.	Static load =	33,350 lb.
Dynamic force =	9,190 lb.	Dynamic force =	3,080 lb.
Equivalent dynamic weight = 9,190 ÷ 51.2 =	180 lb.	Equivalent dynamic weight = 3,080 ÷ 51.2 =	60 lb.

Resultant dynamic weight $= \sqrt{(180)^2 + (60)^2} = 190$ lb.

Dynamic augment by static method = 240 × 51.2 = 12,290 lb.
True dynamic augment = 190 × 51.2 = 9,730 lb.

Fig. 1—Calculation of actual forces causing dynamic augment

* Office, general superintendent motive power, Southern Pacific Co.

by taking into account the cross forces on the wheels other than the main, it is possible to obtain the same fore-and-aft balance per locomotive, the same maximum dynamic augment per wheel from overbalance, and still reduce the balance in the main wheel from 180 to 92 lb. This is highly desirable, especially in locomotives having four coupled pairs of wheels.

With this method of semi-cross-balancing the reciprocating balance per locomotive is 720 lb., of which 618 lb. is on the adjacent side and 102 lb. is provided by the unbalanced cross forces on the opposite side. On the other hand, if the locomotive is cross-balanced on all the wheels, in the European manner, it would be necessary to increase either the force causing dynamic augment on the main wheels to 180 lb., or exceed the 180-lb. limit on the other wheels. Therefore, it is apparent that with the semi-cross-balancing method the blow on the rail per wheel is lower, but the "nosing" couple is greater than if all the wheels were cross-balanced. Modern locomotives of the 4-6-4 and 4-8-4 types have a high moment of inertia about a vertical axis and the restraints to "nosing" produced by the leading and trailing trucks and the chafing gear have such a powerful leverage that "nosing" is secondary to the problem of reducing the rail stresses under the main wheels. For any given amount of reciprocating balance, it appears that semi-cross-balancing of the coupled wheels offers the greatest relief from these stresses under the main wheels without exceeding any limitation of the force producing dynamic augment.

Referring again to Fig. 1, it is obvious that it is not necessary to include the dead and live loads in the calculations, as they are equally divided between the wheels. The general calculation is as follows:

Let

W_r = Weight of side rod on pin and the included part of pin, lb.

W_h = Weight of crank-pin hub and included part of pin, lb.

W_c = Weight of counterbalances (at crank-pin distance), lb.

d_1 = Distance, side rods to adjacent point of rail contact, in.

d_2 = Distance, crank-pin hub to adjacent point of rail contact, in.

d_3 = Distance, counterweight center to adjacent point of rail contact, in.

d_4 = Distance between points of rail contact, in.

Then cross force equals

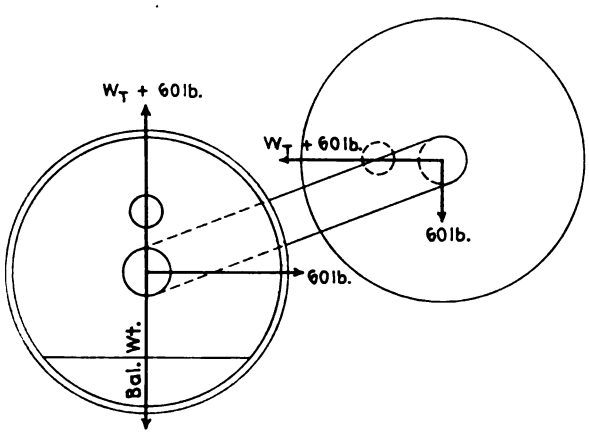
$$C = \frac{W_r d_1 + W_h d_2 - W_c d_3}{d_4}$$

and the force producing dynamic augment is

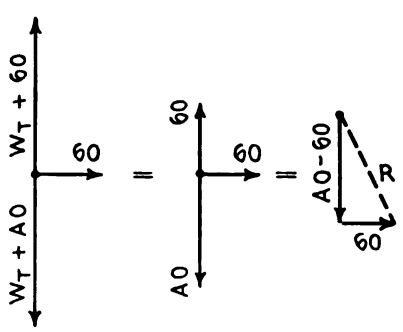
$$F = \sqrt{(W_c - W_r - W_h - C)^2 + C^2}$$

These two equations can be solved for W_c if F and the other weights and distances are known, but it is usually simpler to assume a value of W_c, calculate C and F, and adjust W_c to suit, as C does not change rapidly with W_c. In most cases C and F can be calculated within a few pounds by neglecting the distance between the balance center and the point of rail contact, that is, assume $d_4 = d_3$ and calculate the cross force by the usual A. A. R. formula for cross-balancing wheels.

This latter method was the one used in counterbalancing the recent order of 2-8-8-4 locomotives built for the Southern Pacific by the Lima Locomotive Works and described in the January issue of the *Railway Mechanical Engineer*.



Let W_t = Weight of revolving parts
Then W_c is calculated by usual A. A. R. cross-balance formula (A. A. R. manual, Section F, Pages 135-136—1932)
Cross force = $(W_c - W_t)$ taken as 60 lb. on intermediate wheels
Therefore, $W_c = W_t + 60$ lb. Force in adjacent balance plane due to revolving parts
Apparent overbalance = AO = Balance weight − W_t
Or Balance weight = $W_t + AO$
By vectors:



Resultant R = 180 lb. (Allowable limit)

$(180)^2 = (60)^2 + (AO - 60)^2$

$(AO - 60)^2 = (180)^2 - (60)^2$

$AO - 60 = \sqrt{(180)^2 - (60)^2}$

$AO = \sqrt{(180)^2 - (60)^2} + 60 = 230$ lb.

Fig. 2—Calculation of maximum apparent overbalance

Union Pacific Fourteen-Wheel Tenders

(*Continued from page 388*)

brake parts, which facilitate inspection and replacement of these parts, including the wheels.

This new type of construction made possible the elimination of a number of parts, thus reducing the total weight approximately 15,000 lb. below that of a conventional tender of equal capacity. The light weight of each of these tenders, as constructed, is 160,400 lb., and the loaded weight, 406,500 lb.

Tenders of this new design were built by the American Locomotive Company for service behind the 15 new 4-8-4 type locomotives, delivered to the United Pacific during August and September, 1939. Up to May 1, 1940, these locomotives have accumulated 1,866,786 miles and, during this period, the maintenance has been exceptionally low on both the locomotives and the tenders. The riding qualities are definitely better than with conventional tenders having two swivel trucks. Mileage between turning of wheel treads has been approximately double.

Present indications are that all requirements set up in the development of this new type of tender on the Union Pacific are being obtained in actual service.

* * *

THE DIONNE QUINTUPLETS recently appeared in a coast-to-coast radio program sponsored jointly by the Canadian National and the Canadian Pacific. The first sponsored radio appearance of the "Quints," the broadcast was one in a series of the "Canadian Holiday" program which the two railroads make possible.

Coordinated Associations Meet

Simultaneous conventions of Railway Fuel and Traveling Engineers', Car Department Officers, Master Boiler Makers', and Locomotive Maintenance Officers' Associations to be held at Chicago



Carl Harper, President
Master Boiler Makers' Assn.
A. F. Stiglmeier, Sec.-Treas.



THE four coordinated associations will hold their annual conventions at the Hotel Sherman, Chicago, simultaneously October 22-25, inclusive. This is the fourth successive year that these associations—the Railway Fuel and Traveling Engineers' Association, the Car Department Officers Association, the Master Boiler Makers' Association, and the Locomotive Maintenance Officers' Association—have held their meetings at the same time and place under arrangements made by a coordinating committee on which all are represented. For the second time there will be an exhibit of the Allied Railway Supply Association.

Following the severe setbacks which all of the former minor mechanical department associations suffered during the depression years, normal activities of the four organizations mentioned above were resumed in 1937 under the guidance of the Committee on Coordination of Conventions, of which Frank Roesch, vice-president, Standard Stoker Company, was chairman. These first conventions, accompanied by an exhibit of the Allied Railway Supply Association, were highly successful and marked the beginning of an era of renewed life and usefulness for each of the associations. During this new era their work has been more closely coordinated with



F. L. Kartheiser, Sec.-Treas.
Car Department Officers' Assn.
J. S. Acworth, President



that of the Mechanical Division, A. A. R., and there is developing a growing feeling of mutual confidence and respect between the official association and the voluntary organizations of departmental officers and supervisors.

The Railway Fuel and Traveling Engineers' Association since the amalgamation of its former constituent organizations has become the liaison organization between operating and mechanical departments. Its programs deal with a wide range of problems having to do with the availability of motive power to the operating department and of the handling of trains and equipment on the road.

The Car Department Officers Association, which has developed from the old Chief Interchange Car Inspectors' and Car Foremen's Association, continues to deal with problems of interchange and inspection, but has broadened the scope of its program to include maintenance methods and standards as well as general problems of departmental management.

The Locomotive Maintenance Officers' Association is developing into an organization for the study and discussion of problems of backshop and engine-terminal management, and locomotive-maintenance standards and methods. It provides a forum for the consideration of the many matters of common interest to locomotive terminal and shop supervisors which do not come within the scope of any other organization.

The Master Boiler Makers' Association represents the supervisors of a single craft whose work so strongly affects the usefulness of the locomotive and is in turn so much affected by the conditions under which locomotives operate that it has long had a peculiarly useful place among associations dealing with mechanical-department matters—a place which has been less affected by change as time has passed than that of any of the former minor mechanical organizations.

During the years prior to the depression some overlapping and duplication of effort gradually developed in the programs of these associations. The holding of simultaneous meetings, opened with a joint session in which all participate, is already tending toward the development of a clearer understanding on the part of each of its peculiar function in serving the field covered by all. The continuance of this understanding and cooperation is the function of the Committee of the Coordinated Associations, organized following last Fall's conventions, the membership of which consists of the president and secretary of each of the associations.



T. Duff Smith, Sec.-Treas.

Railway Fuel and Traveling Engineers' Assn.

G. M. Boh, President





F. B. Downey, President

Locomotive Maintenance Officers' Assn.

J. E. Goodwin, Second Vice-President and Sec.-Treas.



Programs of Coordinated Associations

Meeting at Hotel Sherman, Chicago, October 22-25

Joint Session, Tuesday, October 22

Address by Col. Robert S. Henry, assistant to president, Association of American Railroads

Railway Fuel and Traveling Engineers' Association*

TUESDAY, OCTOBER 22

Morning

President's address.
Appointment of special committees.
Proportions of Steam Generated on Locomotive Boilers Used for Various Purposes, by E. E. Chapman, mechanical assistant, A. T. & S. F.

Afternoon

Locomotive Firing Practice — Oil, by Roy W. Hunt, fuel supervisor, A. T. & S. F.
Locomotive Firing Practice — Coal, by W. C. Shove, general road foreman of engines, N. Y., N. H. & H.

WEDNESDAY, OCTOBER 23—MECHANICAL DAY

Morning

New Locomotive Economy Devices, by A. G. Hoppe, assistant mechanical engineer, C., M., St. P. & P.
Address by D. S. Ellis, chief mechanical officer, C. & O.
Utilization of motive power, by A. A. Raymond, superintendent fuel and locomotive performance, N. Y. C.
Turbine and Condensing Locomotives, by L. P. Michael, chief mechanical engineer, C. & N. W.

Afternoon

Report on New York Central Tests at Selkirk, by W. E. Collins, engineer of tests, N. Y. C.

THURSDAY, OCTOBER 24—AIR-BRAKE DAY

Morning

Air Brakes, by J. A. Burke, supervisor air brakes, A. T. & S. F.
(a) No. 8 ET vs. No. 6 ET, by G. H. Higley, general air-brake inspector, Erie.
(b) High-speed Braking with D. 22 Control, by H. I. Tramblie, supervisor of air brakes, C. B. & Q.

Afternoon

Address on The Road Foreman and the Diesel Locomotive, by L. W. Powell, road foreman of engines, A. T. & S. F.

Evening (Movie Night)

Champion Coal.
Acetylene Association film.
Action of draft on Fuel Bed at Various Rates of Firing.

FRIDAY, OCTOBER 25—FUEL DAY

Morning

Coal Preparation, by S. A. Dickson, fuel supervisor, Alton.
Fuel Economy from the Viewpoint of the Chief Dispatcher, by T. O. Weeks, division trainmaster, M. P.
Fuel Records and Statistics, by E. E. Ramey, fuel engineer, B. & O.
Stationary Boiler Plants—Coal Fired, by E. G. Sanders, fuel conservation engineer, A. T. & S. F.
Who Uses and Wastes the Most Fuel, by J. G. Crawford, fuel engineer, C. B. & Q.
Elections.
Secretary-Treasurer's report.
Special Committee Reports—Subjects.

* Revised program.

Car Department Officers' Association

TUESDAY, OCTOBER 22

Morning

Approval of minutes of last annual meeting.
President's address.

Afternoon

Reports of Membership Committees:
Northeast district — A. J. Krueger, general chairman.
Southeast district—E. S. Smith, general chairman.
Southwest district — F. E. Cheshire, general chairman.
Northwest district — G. R. Andersen, general chairman.
Report of Secretary-Treasurer.
Report of unfinished business.
Report of new business.

WEDNESDAY, OCTOBER 23

Morning

Report of Publicity Committee—E. L. Woodward, western editor, Railway Mechanical Engineer, chairman.
Address: Importance of the car department in the function of rail transportation, by J. M. Symes, general manager, Western Lines, Pennsylvania, and second vice-president, Indianapolis Union Ry.
Report of Freight and Passenger Car Construction and Maintenance Committee—D. J. Sheehan, superintendent motive power, C. & E. I., chairman.
Report of Shop Operation, Facilities and Tools Committee — J. A. Deppe, superintendent car department, C. M. St. P. & P., chairman.

Afternoon

Report of Passenger Train Car Terminal Handling Committee—E. J. Hollahan, general car foreman, Illinois Central, chairman.
Report of Lubricants and Lubrication Committee—J. R. Brooks, supervisor lubrication and supplies, C. & O., chairman.

THURSDAY, OCTOBER 24

Morning

Report of Freight Car Inspection and Preparation for Commodity Loading Committee — F. J. Swanson, general car department supervisor, C. M. St. P. & P., chairman.
Address: Car maintenance, performance and expense, by O. A. Garber, chief mechanical officer, Missouri Pacific Lines.
Report of Interchange and Billing for Car Repairs Committee—M. E. Fitzgerald, master car builder, Chicago & Eastern Illinois, chairman.

Afternoon

Report of A. A. R. Loading Rules Committee —H. H. Golden, supervisor of A. A. R. interchange and accounting, L. & N., chairman.

FRIDAY, OCTOBER 25

Morning

Report of Painting Committee — C. L. Swing, general foreman, Pullman-Standard Car Mfg. Co., chairman.
Report of Booster Committee—Brad S. Johnson, sales engineer, W. H. Miner, Inc., chairman.
Report of Reception Committee — W. J. Demmert, sales agent, Griffin Wheel Co., chairman.
Suggestions for good of the association.

Afternoon

Report of the Nominating Committee — J. E. Keegan, chief car inspector, Pennsylvania, chairman.
Election of officers.

Master Boiler Makers' Association

TUESDAY, OCTOBER 22

Morning

President's address.
Remarks by L. B. Rhodes, president, Allied Railway Supply Association.

Afternoon

History of the Association by John A. Doarnberger.
Address by Dr. Edward C. Elliott, president, Purdue University.
Topic No. 2. Pitting and corrosion on firebox sheets and rivet heads.
Discussion of topics for 1941 meeting.

WEDNESDAY, OCTOBER 23

Morning

Business session.
Address by M. A. Quinn, general master mechanic, D. L. & W.
Topic No. 5. Application of iron, steel and alloy rivets with recommendations for heating and driving.
Illustrated paper by Ray McBrain, engineer of tests, D. & R. G. W., on Service aging of firebox materials.

Afternoon

Topic No. 3. (Continued from 1939)—Improving circulation in the locomotive boiler — Increasing feedwater temperature — Detrimental effects on circulation due to improper firing practices—Proper firing up and cooling down of boilers—Design of new boilers to improve their water-carrying properties.
Secretary-Treasurer's report.
Committee on Law.

THURSDAY, OCTOBER 24

Morning

Topic No. 1. Use of acetylene and electric processes in the boiler shop.
Paper with illustration by a committee of the International Acetylene Association, on Use of oxy-acetylene cutting and welding in the boiler shop.
Paper with illustrations by W. G. Theisinger, welding and metallurgical engineer, Lukens Steel Co., on Heat and mechanical stresses in welding and the forming and rolling of heads and plates.

Afternoon

Topic No. 6. (Continued from 1939.) Longitudinal cracking of flues in service.
Topic No. 8. Tender-cistern maintenance practices.

FRIDAY, OCTOBER 25

Morning

Topic No. 4. (Continued from 1939.) Chemical treatment of boiler feedwater.
Topic No. 7. Causes and control of cinder cutting.

Afternoon

Report of the Committee on Resolutions.
Report of the Committee on Memorials.
Report of the Executive Board.
Election of officers.

Locomotive Maintenance Officers' Association

TUESDAY, OCTOBER 22

Morning

President's opening address and report.
Secretary-Treasurer's report.
Introduction of members present.
Appointment of Nominating Committee.

Afternoon

What Members of the L. M. O. A. Can Do to Improve the Service on All Railroads — Address by C. B. Hitch, superintendent of motive power, C. & O.

WEDNESDAY, OCTOBER 23

Morning

The Design, Operation and Maintenance of Diesel Electric Locomotives, by H. V. Gill, supervisor of Diesel engines, Santa Fe System.
Future Locomotive Air Brake Maintenance, by J. P. Stewart, general supervisor of air brakes, Missouri Pacific Lines.

Afternoon

Use of Modern Machinery and Tools in Locomotive Repairs—Address by D. J. Sheehan, superintendent motive power, C. & E. I.

THURSDAY, OCTOBER 24

Morning

Roundhouse Problems of the Present Day—Address by H. E. Hinds, assistant mechanical engineer, C. B. & Q.
Election of Officers.

Afternoon

Luncheon in honor of Advisory Board.
Speaker: John M. Hall, director of Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C. Subjects: The Responsibility of the Locomotive Maintenance Officer and the Federal Inspector.
Remarks by Advisory Board Members:
O. A. Garber, chief mechanical officer, Missouri Pacific.
D. S. Ellis, chief mechanical officer, C. & O.
J. Roberts, chief of motive power and car equipment, Canadian National.

FRIDAY, OCTOBER 25

Morning

Maintenance of Locomotives on Long Runs, by Lee Robinson, superintendent of equipment, Illinois Central System.

Afternoon

Secretary-Treasurer's report of convention.
Installation of new president and officers.
Outline for 1941.

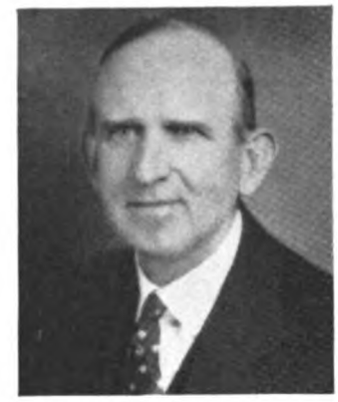
Over 100 companies represented in

Allied Railway Supply Exhibit



L. B. Rhodes, President

Nearly 10,000 sq. ft. of space assigned in second exhibit held in connection with coordinated railway association meetings. More applications pending



J. E. Gettrust, Secretary

THE second large exhibit of the Allied Railway Supply Association at the conventions of the Railway Fuel and Traveling Engineers' Association, the Car Department Officers Association, the Master Boiler Makers' Association, and the Locomotive Maintenance Officers' Association will be held at the Hotel Sherman, Chicago, October 22 to 25, inclusive. The first exhibit of this organization of railway supply companies was held at the same place during the first simultaneous meetings of the co-ordinated associations in the fall of 1937.

The exhibit will occupy a floor space of about 38,500 sq. ft. on the mezzanine floor and in the adjoining main exhibit hall. Of this total floor space about 11,600 sq. ft. are available for actual booth spaces, of which there are 315 6-ft. by 5-ft. units and nine larger spaces of varying shapes and sizes. As this issue goes to press space has been assigned to more than 100 exhibitors. There are a number of other applications under negotiation.

The Allied Railway Supply Association

The Allied Railway Supply Association was organized in 1931. Because of the depression which halted the activities of the various railway associations with which it and its predecessors were associated, however, its first exhibit was not held until the resumption of full activity by the four co-ordinated associations with the meetings in 1937.

The officers who have been conducting the affairs of the association since the last convention and who are responsible for organizing the present exhibit are as follows: President, Lewis B. Rhodes, Vapor Car Heating Company, Washington, D. C.; first vice-president, J. W. Fogg, vice-president and general sales manager MacLean-Fogg Lock Nut Co., Chicago; second vice-president, C. F. Weil, American Brake Shoe & Foundry Co., Chicago; third vice-president, and treasurer, F. W. Venton, manager, railroad sales department, Crane Co., Chicago; fourth vice-president M. K. Tate, Lima Locomotive Works, Lima, Ohio; fifth vice-president H. S. Mann, Standard Stoker Co., Chicago; sixth vice-president, R. T. Peabody, Air Reduction Sales Co., New York; secretary J. F. Gettrust, The Ashton Valve Co., Chicago.

The Committee Chairmen

The work incidental to the organization of the exhibit, entertainment and assistance to the railway organizations in facilitating the conduct of their meetings has been assigned to six committees. These committees are in charge of the following chairman:

EXHIBIT

John W. Baker, vice-president, Locomotive Firebox Co., Chicago.

REGISTRATION

M. K. Tate, Lima Locomotive Works, Lima, Ohio.

ENTERTAINMENT

J. W. Fogg, vice-president and general sales manager, MacLean-Fogg Lock Nut Co., Chicago.

PROGRAM

F. C. Hasse, general manager, Oxweld Railroad Service Co., Chicago.

PUBLICITY

Roy V. Wright, editor, *Railway Mechanical Engineer*, New York.

The entertainment of the ladies will be in charge of a committee of which Mrs. Lewis B. Rhodes is chairman.

The Exhibit

The list of exhibitors, the products which they will show, and the names of the representatives in attendance, follow:

Air Reduction Sales Company, Chicago and New York.—Airco oxygen and acetylene; National carbide; Airco welding and cutting apparatus and supplies; electrodes; Wilson arc-welding machines. Represented by C. B. Armstrong, J. W. Benefic, M. M. Weist, and J. F. Franzen. Space 218.

Airetool Manufacturing Co., The, Springfield, Ohio.—Tube cleaners for boiler tubes, arch tubes, branch-pipe and circulating tubes. Represented by G. F. Ilgen and Leo C. Fintel. Space 172.

Ajax Hand Brake Co., Chicago and New York.—Ajax hand brakes for all classes of railway freight equipment. Represented by R. W. Burnett, J. H. Shaffer, C. R. Moline, and S. R. Polasek. Spaces 27, 28, and 29.

American Arch Company, Inc., New York and Chicago.—Security circulator; Security brick arch. Represented by B. A. Clements, Geo. A. Price, J. D. Brandon, John P. Neff, Thos. Mahar, A. H. Willett, M. S. Boyle, G. M. Bean, A. F. Becker, L. A. Clugh, E. H. Doerr, T. M. Ferguson, Wm. Haag, Thos. F. Kilcoyne, E. T. Mulcahy, W. E. Salisbury, and A. M. Sucese. Spaces 91, 92, 93, 102, 103, and 104.

American Locomotive Company, New York.—Lateral-cushioning device; lightweight alloy-steel rods; Universal spring plates; journal-box lid. Represented by F. S. Allen, E. J. Brown, W. A. Callison, W. S. Morris, N. C. Naylor and C. S. Venrick. Spaces 183, 184, 185 and 186.

Apex Tool & Cutter Co., Inc., The, Shelton, Conn. — Inserted drop-forged tools and holders for railroad metal-cutting operations; inserted-tooth milling cutters; Carboloy-tipped tools for use in holders. Represented by F. J. Wilson, Trent Mays, and L. F. King. Spaces 174 and 175.

Arrow Tools, Inc., Chicago.—Space 201.

Ashton Valve Co., The, Cambridge, Boston, Mass.—Locomotive safety valves; double- and single-dial locomotive steam and pilot gages; duplex back-pressure gages; feedwater heater; booster; illuminated quadruplex and single air gages; wheel-press recording gages and attachments for double wheel mounting; locomotive driving-wheel quartering gages; weight gage testers, etc. Represented by J. F. Gettrust, J. W. Motherwell, Charles Gaston, John Welsh, and E. C. Kenyon. Spaces 235 and 236.

Barco Manufacturing Company, Chicago.—Barco new double whistle low-water alarm; Barco Type M power reverse gear; new improved M-3 reverse gear valve; new improved 3VX steam, air, oil and water connections between locomotive and tender; 2-in. and 2½-in. car steam-heat connections. Represented by F. N. Bard, C. L. Mellor, W. J. Behlke, C. O. Jenista, F. B. Nugent, J. L. McLean, W. T. Jones, C. C. Cox, and L. J. Lytle. Spaces 74, 75, 120, and 121.

Barrett-Christie Co., Chicago.—Coffing hoists; Wells band-saw machines Oster pipe-threading machines. Represented by Harry Barrett, J. G. Christie, R. P. Kemp, R. D. Christie, J. E. Banks, H. N. Hayes, R. S. Acord, Orin Ash and C. E. Millard. Spaces 255, 256, 281, 282, 283, and 284.

Beaver Pipe Tools, Inc., Warren, Ohio. — Pipe- and bolt-cutting and threading tools and machines. Represented by Avery Phillis, and E. R. Barkley. Spaces 243, 244, and 245.

Berkley Machine Works & Foundry Co., Inc., Berkley, Norfolk, Va.—Berkley stoker. Represented by Samuel G. Jones. Spaces 50-53, inclusive.

Boss Bolt & Nut Co., Chicago.—Space 280.

Buckeye Steel Castings Company, The, Columbus, Ohio. — Six-wheel truck model; retractable coupler model; Type E coupler model; model of draft-gear assembly; four-wheel spring plankless truck model, and enlarged photographs of "all service" and eight-wheel trucks. Represented by F. J. Cooledge, Geo. A. Sutherland, M. R. Hansen, and R. H. Gaver. Spaces 214 and 215.

Chicago Pneumatic Tool Company, Chicago.—CP speed recorder; pneumatic and electric tools; air compressors. Represented by H. R. Deubel, C. L. Butler, W. Pallowick, and E. S. Rosselle. Space 189.

Cleveland Steel Tool Co., The, Cleveland, Ohio.—Punches; dies; rivet sets; chisel blanks. Represented by R. J. Venning, H. W. Leighton, and H. A. Lacerda. Space 173.

Collins & Aikman Corp., New York.—Transportation angora velvet upholstery fabrics. Represented by E. A. Smith and E. O. Fricker. Spaces 237, 238, and 239.

Corley Company, The, Jersey City, N. J. — Corley OK-TAG-ON-AL unions and fittings. Represented by Ralph A. Corley and George W. Bender. Spaces 16 and 17.

Crane Co., Chicago.—Full Crane line of A. A. R. valves and fittings, featuring carbon-molybdenum cast-steel O. S. & Y. globe and angle valve for 600 lb., 750 deg. F. Represented by F. W. Venton, G. G. Lindholm, and K. E. Watson. Spaces 285, 286, and 287.

Dampney Company of America, The, Hyde Park, Boston, Mass.—Automatic Apexior coating machine for locomotive boiler flues, also Apexiorized flues after service in boiler equipment, etc. Represented by C. J. Hunter and J. D. Bird. Spaces 163 and 164.

Dearborn Chemical Co., Chicago.—Boiler feedwater treatment; automatic wayside water treatment proportioning equipment; automatic blow-off and Foam level indicating equipment; apparatus for field tests of water samples; No-Ox-Id rust preventives. Represented by George R. Carr, R. A. Carr, R. O. Milnes, S. C. Johnson, L. O. Gunderson, F. B. Horstmann, W. H. Hinsch, C. C. Rausch, A. H. Reynolds, J. W. Nelson, O. W. Carrick, F. J. Boatright, L. D. Brown, R. A. Dalton, E. R. Glover, E. A. Goodnow, Fred Hooker, J. F. Johnson, T. F. Klein, R. J. Maginn, A. M. Novak, L. K. Ross, and B. H. Stone. Space C.

Detroit Lubricator Co., Detroit, Mich.—Locomotive, mechanical and hydrostatic lubricators; flange oilers; accessories for complete mechanical chassis lubrication. Represented by C. E. Sperry and E. F. Milbank. Spaces 222 and 223.

Duff-Norton Manufacturing Company, The, Pittsburgh, Pa. — Lifting jacks; power jacks; journal jacks; automatic lowering jacks; governor controlled self-lowering jacks; ball-bearing jacks. Represented by Robert G. Allen, W. I. Floyd, Earl E. Thulin, David F. Evans, Albert Roberts, George L. Mayer, James Gilchrist, Jr., and C. N. Thulin. Space F.

Durametallic Corporation, Kalamazoo, Mich., and Newark, N. J.—Packings for air pumps, cab cocks, reverse gears, booster engines, expansion joints, stoker engines, gage glass, feedwater heater pumps, valve rods, throttles and steam-admission pipes. Represented by Roscoe R. Smith, Herbert Lewis, J. J. McQuillen, Ralph Morgan, Frank Rollo, George W. Shriver, and M. Dale Ogden. Spaces 165 and 166.

Du-Wel Steel Products Co., Chicago.—Coupler centering device; roller side bearing; pipe clamps; A. B. branch-pipe Tee support. Represented by J. V. Wescott, C. M. Baker, R. M. Mulvey, and D. D. Wescott. Space 224.

Edna Brass Manufacturing Company, The, Cincinnati, Ohio.—Edna single lever injector; Fig. 339 Positive oil dividers; Positive drain reflex water gage; Model A mechanical force feed lubricator with regrindable unit 30 line checks; Type TA high-pressure terminal valve; Nelson automatic steam gage valve; Ednaloy engineered metals. Represented by John T. Ash, William Beck, B. I. Kaufmann, E. F. O'Connor and John F. Deems. Spaces 138, 139, and 140.

Ewald Iron Co., Louisville, Ky.—Space 229.

Flannery Bolt Co., Bridgeville, Pa. — Spaces, 80, 81, 82, 113, 114, and 115.

Franklin Railway Supply Company, Inc., New York and Chicago—Compensator and snubber; driving-box lubricator and spreader; flexible connections; fire doors; power reverse gears, etc. Represented by H. F. Ball, W. H. Coyle, H. M. Evans, C. W. F. Coffin, J. E. Long, W. T. Lane, D. I. Packard, G. W. Alcock, and T. C. Gray. Spaces 83 to 88 and 107 to 111.

Gilg, Henry F., Pittsburgh (12). — Specimens of Dunkirk solid and rolled-hollow staybolt steel; Gilg valve. Represented by J. C. Campbell and J. S. Lemley. Space 213.

Globe Steel Tubes Co., Milwaukee, Wis. — Spaces 158 and 159.

Graham-White Sander Corporation, Roanoke, Va.—Graham-White sanders, sand spreaders, and car-spring snubbers. Represented by Virgil L. Frantz, Frank H. Cunningham, and John S. Lemley. Spaces 42, 43, 60, and 61.

Griffin Wheel Company, Chicago. — Railroad chilled car wheels. Represented by W. J. Demmert, J. M. Welles, J. P. Maher, W. J. Fitzsimmons, and E. W. McDonald. Spaces 225 and 226.

Grip Nut Company, Chicago.—Reception booth. Represented by John H. Sharp, L. W. Kass, and E. H. Weigman. Spaces 205, 206, and 207.

Hanna Stoker Co., Cincinnati, Ohio.—Spaces 36, 37, 66, and 67.

Holland Company, Chicago.—Friction volute snubber springs; CAP-KO refrigerator car hatch closure; CAP-KO refrigerator-car-door fixtures. Represented by Cyrus J. Holland, Cyrus E. Holland, and Cal. W. Wulff. Space 1.

Hulson Grate Company, Keokuk, Iowa.—Hulson Tuyere type locomotive grate. Represented by J. W. Hulson and H. N. Gardner. Spaces 197, 198, and 199.

Hunt-Spiller Manufacturing Corporation, South Boston, Mass.—Hunt-Spiller lightweight valve; duplex sectional cylinder and valve-packing rings; Z-type pistons; crosshead shoes; Diesel liners, etc. Represented by V. W. Ellet, F. W. Lampton, D. F. Hall, E. J. Fuller, C. L. Galloway, and K. A. Craig. Spaces 141 and 142.

Huron Manufacturing Company, Detroit, Mich.—Washout plugs and bushings; arch-tube plugs and bushings; Huron Venetian spark arresters; Kales pressure-welded running boards and brake steps; direct-steaming connections; Ace self-feeding grease cups. Represented by Paul C. Cady, Louis E. Hassman, Robert J. Sherlock, Austin C. Ruse, Thomas R. King, and Trent Mays. Spaces 18 and 19.

International Correspondence Schools, Scranton, Pa. — Represented by C. G. Ash, A. C. Drynan, J. T. Gill, David Groves, Wm. E. Lamb, Ivan F. Stephens, and A. A. Welton. Spaces 220 and 221.

Irving Subway Grating Co., Inc., Long Island City, N. Y.—Model of Safkar steps; running boards for freight cars. Represented by H. W. Stahl and C. H. Lewis. Space 241.

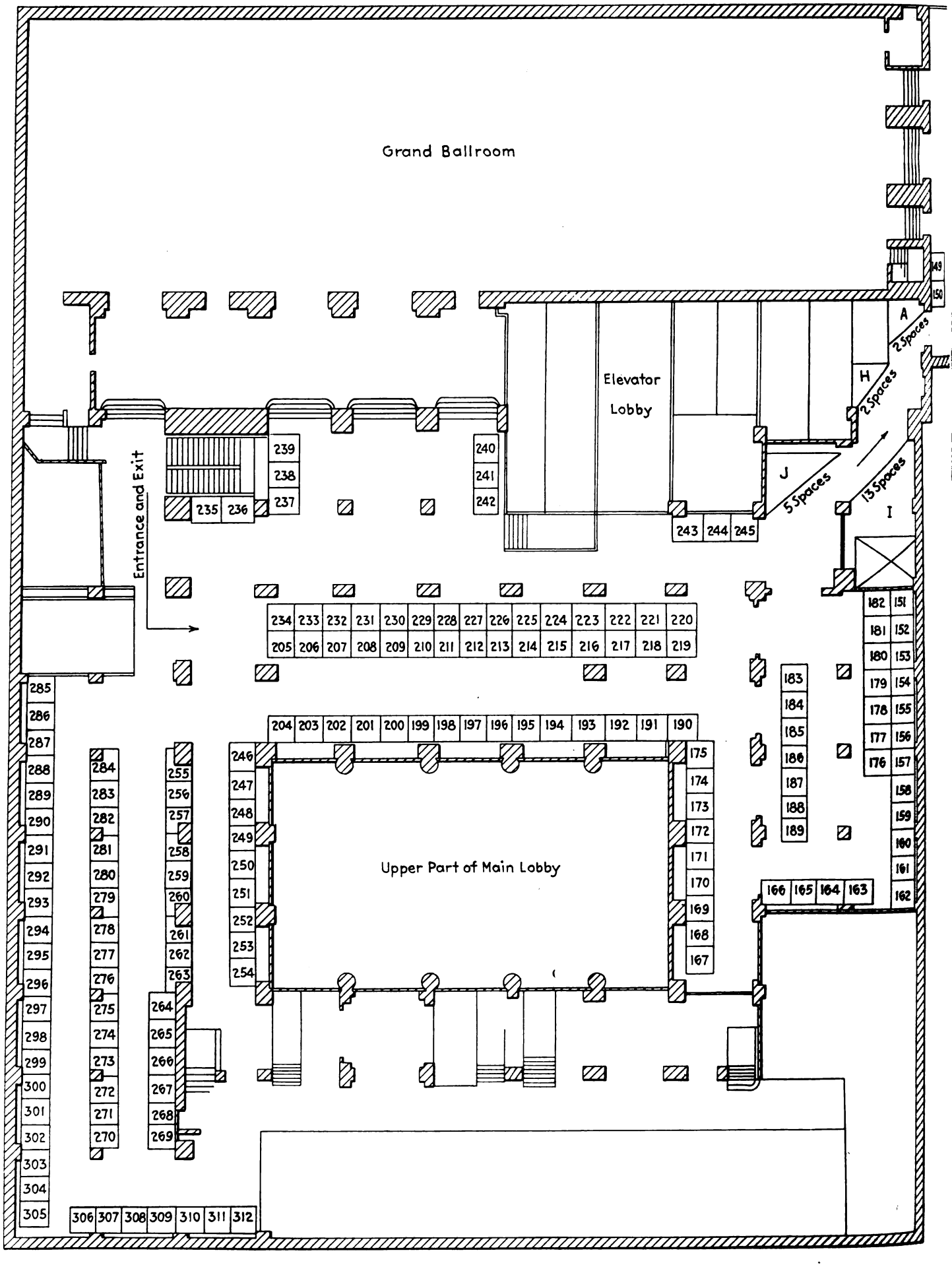
Johns-Manville, New York.—Locomotive and power-plant packing; locomotive, passenger-car and refrigerator-car insulations. Represented by P. R. Austin, C. E. Bryant, C. S. Clingman, Elliot Fairback, S. H. Flannagan, R. J. Offutt, T. O'Leary, Jr., C. M. Patten, H. R. Poulson, W. W. Prosser, G. R. Tierney, R. P. Townsend, John H. Trent, F. C. Vandervort, and L. T. Youhn. Spaces 288 to 291, inclusive.

Joyce-Cridland Company, The, Dayton, Ohio.—Complete line of railroad jacks, including air-motor hoists, journal jacks, track jacks, automatic lowering jacks, geared ratchet lever jacks, self-lowering jacks, etc. Represented by Huston Brown, Merle P. Smith, D. H. McAdams, Adrian Walker, R. C. McDonald, and W. F. Weber. Spaces 22 and 23.

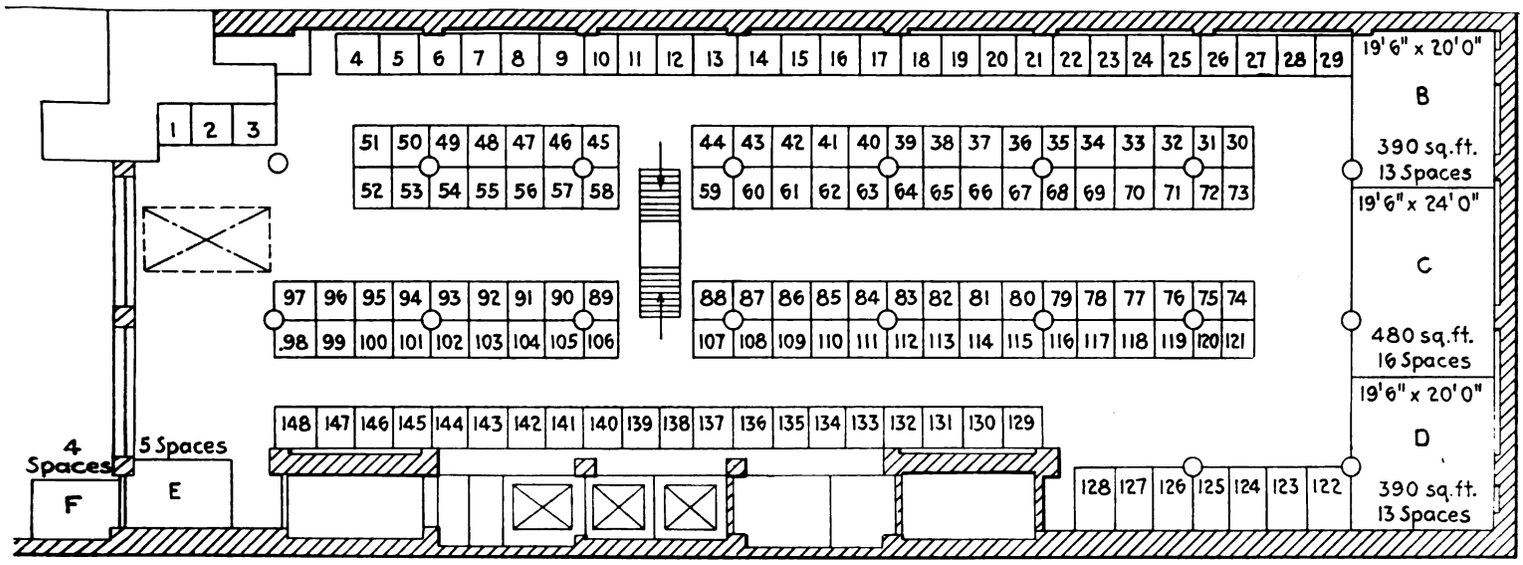
Lehon Company, The, Chicago.—Small samples of various mechanical-department specialties. Represented by J. W. Shoop, H. A. Wolfe, J. E. Eipper, R. J. Mulroney, and A. C. Senseney. Space 200.

Lewis Bolt & Nut Company, Minneapolis, Minn.—Sealtite car bolts; Macer journal-bearing protectors; Sealtite Staybolt hole bushings. Represented by H. W. Johnson and R. B. Hill. Space 246.

Lima Locomotive Works, Incorporated, Lima, Ohio.—Reception booth. Represented by A. J. Townsend and M. K. Tate. Space No. 105.



Arrangement of exhibit spaces at the Hotel Sherman—Mezzanine floor



Arrangement of Exhibit spaces at the Hotel Sherman—The main exhibition hall

Locomotive Finished Material Co., Atchison, Kan.—Martin locomotive stoker and power engine; one-piece Z-type lightweight piston and lipped type combination universal sectional bull and packing rings; model of the Universal design main driving-wheel center; model of one-piece cast-steel cylinder. Represented by R. L. McIntosh, A. H. Moorhead, Wm. Purcell, G. W. Taylor, and Wm. O. Martin. Spaces 294, 295, 296, 297, and 298.

Locomotive Firebox Company, Chicago.—Nicholson Thermic syphons; Cyclone front ends; Christy pneumatic lubricators, and syphon sanders. Represented by W. S. Carr, L. R. Pyle, John Baker, C. M. Rogers, B. E. Larson, M. A. Foss, K. L. Boyette, E. J. Reardon, E. Frank Smith, and Fred Bramley. Space B.

Lunkenheimer Co., The, Cincinnati, Ohio.—A. A. R. valves; valves for blower service; feedwater heater and stoker throttles; lubricators, and other engineering appliances. Sectioned samples. Represented by W. George Cook, Karl B. Litzelmann, and I. A. Orth. Spaces 122 and 123.

MacLean-Fogg Lock Nut Company, Chicago.—Lock nuts; nut locks; floor clips; dust guards; defect-card receptacles. Represented by J. W. Fogg, J. A. MacLean, Jr., A. W. MacLean, H. J. Cearity, L. A. Rowe, E. G. Doke, and H. J. Voss. Spaces 116, 117, and 118.

Mall Tool Company, Chicago.—Portable electric saws; portable electric drills; portable flexible shaft machines for shop use. Represented by F. A. McGonigle, M. Rehnquist, A. W. Hall, M. L. Riley, and D. Soderberg. Spaces 227 and 228.

Midland Company, The, South Milwaukee, Wis.—Midland sealed door safety fixtures; combination safety stop and door hanger; door hangers; door fixtures for baggage, express and mail cars. Represented by Clair P. Nourse, Howard P. Cook, Robert Nourse, and Frank G. Schwartz. Space 20.

Miner, W. H., Inc., Chicago.—Small models of friction draft gears, truck-spring snubbers, hand brakes, etc. Represented by H. S. Brooks, Bradley S. Johnson, L. A. Marquardt, A. R. Nelson, R. J. Olander, A. G. Peterson, W. G. Roth, W. J. Trongeau, and R. H. Weber. Space 230.

Monarch Packing & Supply Company, Chicago.—Packings. Represented by W. P. Lyons, C. C. Humberstone, Stanley MacDole, and Wm. J. Forbes. Space 44.

Morton Manufacturing Company, Chicago.—Morton Open-Grip freight-car safety metal running boards and brake steps. Represented by Charles D. Morton, John D. Cannon, James A. King, Walter A. Klopsch, Carl H. Kadie, Chester T. Stansfield, George H. Goodell, and James B. Peddle. Spaces 129 and 130.

Murdock Mfg. & Supply Co., The, Cincinnati, Ohio.—Murdock water service boxes; outdoor anti-freezing hydrants; drinking fountains and street washers; Murdock QOC air valves, and Murdock EP air check valves. Represented by Thomas E. Bart. Spaces 209 and 210.

Nathan Manufacturing Company, New York.—Mechanical lubricators; oil distributors; atomizers; injectors and starting valves; boiler drop plugs; water column and water gage; boiler check valves. Represented by Fred Ehredt, J. F. Farrell, B. Folke, R. H. Jenkins, J. A. Kelly, J. D. Spaulding, and Richard Welsh. Spaces 40, 41, 62 and 63.

National Aluminate Corporation, Chicago.—Nalco Waterlab; Unit type water-treating plant; automatic continuous blowdown system; slides showing story of water treatment. Represented by W. R. Anthony, C. M. Bardwell, B. D. Barger, C. A. Brown, J. L. Callahan, P. W. Evans, C. B. Flint, J. L. Gibboney, R. J. Hill, R. V. Lucas, H. A. Marshall, V. E. McCoy, E. M. Miller, H. H. Richardson, H. D. Shaw, and T. G. Windes. Spaces 151 to 157 and 176 to 182, inclusive.

National Malleable and Steel Castings Company, Cleveland, Ohio.—Full-size draft gears; models of couplers, yokes, journal box and truck. Represented by T. W. Aishton, J. F. Hutson, F. E. Moffett, and E. A. Powell. Spaces 211 and 212.

Oakite Products, Inc., New York.—Tank-car cleaning unit, Model 324, for cleaning tank-car interiors; Oakite solution-lifting steam gun, Model 385, for steam cleaning operations; solution-lifting air gun, Model 391, for cleaning certain types of air-conditioning equipment on railroad coaches, etc.; various new Oakite materials for special railway maintenance cleaning work. Represented by B. C. Browning, J. C. Leonard, L. B. Johnson, and H. L. Gray. Space H.

Ohio Injector Co. of Illinois, The, Chicago.—Reception booth. Represented by Frank Wm. Edwards, W. H. Malone, and Howard F. Meyers. Spaces 187 and 188.

Okadee Company, The, Chicago. — Blow-off valves; safety water-glass protectors; air-operated cylinder cocks; blow-off separators; steam-operated cylinder cocks; blow-off mufflers; tender hose couplers; drain valves. Represented by D. P. Morgan, J. F. Raps, C. G. Learned, C. W. Ploen, G. E. Johnson, I. W. Hebner, and B. B. Rich. Spaces 116, 117, 118, and 119.

O'Malley, Edward, Valve Co., Chicago.—No. 660 Dual stoker-operating valve; No. 770 Dual stoker-operating valve A. A. R.; No. 643 quick-opening blower valve, 1 in. and 1¼ in.; gage cocks; water-glass valves and other valves; Master valve repair set. Represented by S. C. Boston, Edward O'Malley, Sr., and Edward O'Malley, Jr. Spaces 46, 47, 56, and 57.

Oxweld Railroad Service Company, The, (unit of Union Carbide and Carbon Corporation), New York.—Machine-cutting, hand-cutting and welding blowpipes, including Oxweld C-12-R machine-cutting blowpipe, W-24-R welding blowpipe, and C-14-R cutting blowpipe with special nozzle for cutting scrap. Photo-enlargements showing shape cutting and the cutting of piled plates with the oxyacetylene cutting machine, the welding of locomotive piping, and bronze welding in repair work. Represented by L. Adams, M. C. Beymer, G. P. Bogert, M. Burnett, Jr., T. A. Cash, E. Cordeal, M. A. Deaton, R. J. Dodds, F. C. Hasse, G. Hauskins, W. A. Hogan, W. Jones, J. E. Kniple, O. F. Ladtkow, J. J. Langdon, W. Leighton, W. H. Matthes, J. W. O'Neill, J. W. Ritcey, J. H. Rodger, M. J. Rotroff, H. W. Schulze, and A. L. West. Spaces 76, 77, 78, 79, 116, 117, 118, and 119.

Paxton-Mitchell Co., Omaha, Neb.—Paxton-Mitchell metallic piston-rod and valve-stem packing; locomotive cab window; Leathem power reverse gear; special iron and locomotive castings. Represented by James L. Paxton, Jr., James L. Keliher, Howard W. Dillon, E. M. Hendrickson, and G. A. Blistain. Spaces 131, 132 and 133.

Penn Iron & Steel Company, Creighton, Pa.—Sample test specimens of staybolt iron. Represented by Chas. J. Nieman and John W. Davis. Space 45.

Pilliod Company, The, Swanton, Ohio, New York and Chicago.—New style reverse yoke and radius bar (for Baker valve gear) equipped with needle bearings and forged bell crank; framed photographs and locomotives recently equipped with Baker valve gear. Represented by Frank Fisher, L. R. Baker, F. E. Pilliod, and R. H. Weatherly. Spaces 216 and 217.

Pocket List of Railroad Officials, New York.—Publication. Represented by Harold A. Brown and B. J. Wilson. Space 204.

Portable Plating & Equipment Company, Chicago.—Jenkins leather fibre dust guards; Atlas safety and hydraulic jacks; Supersoly products; Firestone rubber tie plates. Represented by J. E. Buckingham, A. W. Donop, and S. A. Stephens. Spaces 14 and 15.

Prime Manufacturing Company, The Milwaukee, Wis.—Prime automatic cylinder protection valves; steam cylinder cocks and operating valves; cab panels, ventilators and windshield wings; cab curtains. Represented by H. B. Nelson, C. K. Ramp, J. A. Lucas, and D. A. Kelly. Spaces A, 149 and 150.

Pyle-National Company, The, Chicago. — Headlights; turbo-generators; back-up, marker and classification lights; floodlights; locomotive and car electrical fixtures and fittings; safety switches; portable hand lamps; vapor-tight fittings, plugs and receptacles for battery charging, air conditioning and general purpose. Represented by J. A. Amos, J. V. Baker, W. W. Booth, W. H. East, G. E. Haas, A. E. Johnson, W. A. Ross, and W. A. Wulle. Space D.

Q & C Co., The, New York.—Mechanical lubricator; roller truck side bearing; emergency coupler knuckle. Represented by Lewis Thomas, L. E. Hassman, and E. I. Hetsch. Space 242.

Railway Purchases and Stores, Chicago.—Copies of publication. Represented by Edward Wray, K. R. Sheeran, and J. P. Murphy, Jr. Space 219.

Reliance Machine & Stamping Works, New Orleans, La. — Spaces 292 and 293.

Ryerson, Joseph T., & Son, Inc., Chicago.—Lewis special staybolt iron. Represented by J. P. Moses, A. M. Mueller, G. L. Shinkle, W. R. Lockwood, and R. W. Burt. Space 58.

Sargent Company, Chicago.—Locomotive steam specialties: quick-acting blower valves; water columns; safety water-glass cocks; Sargent water-glass protectors; double-seat gage cock. Represented by Frederick W. Becker, Louis L. Schultz, and W. H. Heckman. Space 208.

Wm. Sellers & Company, Incorporated, Philadelphia, Pa. — Injectors, checks, steam lever valves, drifting valves, strainers, boiler washers and testers, locomotive and box-car washing apparatus. Represented by P. E. Raymond, James R. New, and I. P. Pedrick. Spaces 202 and 203.

Simmons-Boardman Publishing Corporation, New York.—Railway Mechanical Engineer and other transportation magazines and books. Represented by L. B. Sherman, R. E. Thayer, H. A. Morrison, F. H. Thompson, H. H. Melville, H. E. McCandless, S. W. Hickey, C. W. Merriken, Jr., R. V. Wright, C. B. Peck, E. L. Woodward, H. C. Wilcox, and C. L. Combes. Spaces 232, 233, and 234.

Sinkler, Joseph, Inc., Chicago.—J-S Style No. 66 semi-metallic locomotive packing; Milwaukee portable locomotive crank-pin grinder; Tom automatic drain valves; Thompson boiler plugs; Duro electrode holders. Represented by Joseph Sinkler and Helen Sinkler. Spaces 48, 49, 54 and 55.

Spring Packing Corporation, Chicago.—Space 247.

Standard Brake Shoe & Foundry Co., Pine Bluff, Ark., and Memphis, Tenn.—Duo-Cast metal for locomotive grates and Stanfast spring bands for locomotive springs. Represented by Earle A. Mann, Robert E. Mann, and Adrian A. Walker. Space 24.

Standard Car Sales, Inc., Chicago.—Champion hand brakes; Walton air filters. Represented by R. E. Frame, F. L. Barber, Franklin D. Barber, John B. Edgerton, E. E. Van Cleave, and John D. Ristine. Space 194.

Standard Car Truck Company, Chicago.—Barber stabilized trucks; lateral-motion device; side bearings. Represented by R. E. Frame, F. L. Barber, F. D. Barber, John B. Edgerton, and John D. Ristine. Spaces 192 and 193.

Standard Stoker Company, Inc., The, New York, Chicago, and Erie, Pa.—Mechanical locomotive stoker; model of Type DA coal pusher. Represented by E. A. Turner, F. P. Roesch, J. R. Sexton, C. T. Hansen, C. R. Davison, L. F. Sweeney, G. M. Myers, LeRoy Dysart, E. H. Parr, H. W. Cook, G. A. Edwards, H. N. Carmer, H. J. Atkinson, H. P. Farrington, and Bernard Peyton. Space E.

Superheater Company, The, New York.—Reception booth. Represented by H. C. Bell, L. H. Birkett, T. F. Birmingham, P. D. Blanchard, E. C. Bonistall, C. A. Brandt, H. E. Brown, Bard Browne, S. L. Brownlee, G. L. Dolan, E. J. Drewyour, C. R. Fairchild, Geo. Fogg, J. F. Griffin, H. G. Harrison, T. F. Jackson, H. M. Kirby, E. W. Kush, J. E. Mourne, C. A. Odell, R. M. Ostermann, F. A. Schaff, Ira F. Sharp, F. W. Smith, Chas. H. True, Sr., C. C. Turner, T. J. Vallance, L. R. Bryan, F. J. Dolan, S. Macdonald, B. G. Lynch, T. P. McGinnis, N. T. McKee, R. J. VanMeter, A. Williams, and C. H. David. Spaces 94-101.

Superior Hand Brake Co., Chicago.—Hand brakes and hand-brake chain adjuster. Represented by H. C. Smith and R. C. O'Connor. Spaces 190 and 191.

Superior Railway Products Corporation, Pittsburgh, Pa.—Superior automatic soot blowers for locomotives; pneumatic bell ringers; Auto-Tite flexible joints and metallic steam connectors; Rees jacks. Represented by W. O. Martin and W. E. Larson. Spaces 89 and 106.

Swanson Company, The, Chicago.—S-CO automatic flange oiler; Swanson gage holder. Represented by O. W. Swanson and R. V. Larson. Space 25.

T-Z Railway Equipment Co., Chicago.—General locomotive and car specialties: T-Z metallic packing, blow-off valves; washout plugs, cylinder cocks, tank valves, etc.; pipe clamps, running boards, brake steps, etc. Represented by G. S. Turner, F. J. Kearney, F. B. Platt, G. S. Turner, Jr., and W. H. White. Spaces 30, 31, 72, and 73.

Talmage Mfg. Company, The, Cleveland, Ohio.—Talmage safety water gages. Represented by Frank M. Roby. Space 26.

Timken Roller Bearing Company, The, Canton, Ohio.—Timken railway bearings for car trucks, locomotive driving axles, engine and trailer trucks, and tender trucks, completely mounted in journal boxes; Timken light-weight reciprocating parts for steam locomotives. Represented by W. C. Sanders, P. N. Wilson, C. F. Crowell, and R. J. Daniels. Spaces 4 to 13, inclusive.

Union Asbestos & Rubber Company, Chicago.—Asbestos products. Represented by J. H. Kuhns, O. J. Rudolph, J. B. Crawford, P. S. Nash, G. L. Green, and R. M. Covert. Spaces 195 and 196.

Union Railway Equipment Company, Chicago.—Ureco V-38 high-power vertical wheel hand brake; high-power drop-hand brake; all-metal floor rack for refrigerator cars. Represented by J. G. Forster, R. H. Buck, and E. W. Zane. Spaces 250 and 251.

Unit Truck Corporation, New York.—Unit truck; brake beams; wear plates; side frames. Represented by L. A. Crone, C. R. Busch, E. F. Gladwell. Spaces 1, 2, 3, X1, X2, and X3.

U. S. Metallic Packing Company, The, Philadelphia, Pa.—Metallic packing, lubricators and sanders. Represented by Harry E. Hyslop, Clyde Hyslop, Lewis B. Miller, and Robert E. Buckley. Space 90.

Valve Pilot Corporation, New York.—Loco Valve Pilot; Loco Recorder; automatic train signal forestalling recorder. Represented by William Bell Wait, John L. Davidson, R. S. Folk, C. D. Jones, W. K. Winkler, W. W. Bacon, H. H. Bollinger, C. F. Pennypacker, W. K. Carter, and F. D. Welden. Spaces 38, 39, 64, and 65.

Vapor Car Heating Co., Inc., Chicago.—Zone system vapor for passenger-car heating; thermostatic control of air conditioning; locomotive and car heating specialties; steam generators for Diesel locomotives; Represented by L. H. Gillick, W. H. Tucker, F. E. Hess, E. C. Post, F. B. Rutherford, E. E. Smith, E. A. Russell, J. VanVulpen, P. B. Parks, E. H. Burgess, R. Vlaming, and H. Owen. Spaces 143 to 148, inclusive.

Viloco Railway Equipment Co., Chicago. — Sanders; sander-operating valves; bell ringers and valves; pneumatic whistle operators; by-pass valves; automatic rail washers. Represented by D. P. Morgan, J. F. Raps, C. G. Learned, C. W. Ploen, G. E. Johnson, I. W. Hebner, and B. B. Rich. Spaces 76, 77, 78 and 79.

Westinghouse Air Brake Company, Wilmerding, Pa.—Decelostat for HSC brake equipment; 8½-in. cross-compound compressor with F-1 lubricator and air filter; after-cooler for locomotive air-compressor installation; improved hose couplings, nipples, and clamps; E-2 Pneuphonic horn; latest types of slack adjusters; four-position pressure retaining valve. Represented by S. G. Down, C. H. Beck, G. L. Cotter, C. C. Farmer, C. D. Stewart, J. B. Wright, A. K. Hohmyer, J. S. Y. Fralich, G. C. Farmer, P. H. Donovan, L. M. Carlton, J. R. Holtom, J. B. Ball, Lawrence Wilcox, E. A. Maylock, R. P. Ives, V. B. Emrick, A. G. Huston, F. B. Johnson, D. W. Lloyd, R. J. Knapp, D. R. Collins, C. J. Werlich, T. W. Baldwin, E. H. Weaver, and Thomas G. Myles. Spaces 124 to 128, inclusive.

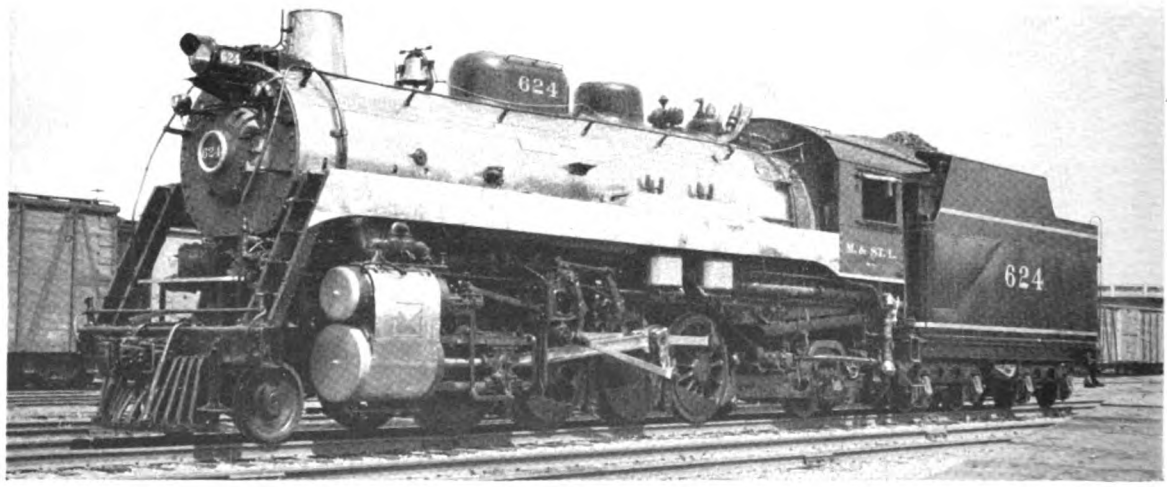
Wilson Engineering Corporation, Chicago. — Reception booth. Represented by J. J. Clifford, J. M. Lammedee, and L. F. Wilson. Space 231.

Wine Railway Appliance Company, The, Toledo, Ohio.—Wine door locks; hopper frames; brake balancers; side bearings; Safe-Grip ladders and grab irons; gondola drop end locks. Represented by Cyrus Hankins, Cleon M. Hannaford, Geo. B. Christian, L. J. Tillman, and Earl H. Fisher. Space J.

Worthington Pump and Machinery Corporation, Harrison, N. J.—Steam valve gear; water valve service; spray valve nozzle; drifting control valve; steam control valve, charts, etc., all pertaining to locomotive feedwater heating equipment. Represented by W. R. Leopold, Fred B. Smith, V. W. Rafferty, Fred B. Griffith, Geo. Dill, E. C. Jackson, L. H. Bishop, Thos. Cruthers, Thos. C. McBride, J. J. Alves, Jr. Space 21.

Youngstown Steel Door Co. and Camel Sales Co., Chicago.—Reception booth. Represented by H. E. Creer, L. F. Duffy, A. G. Dohm, K. J. Tobin, G. R. Treptow, E. C. Browne, W. A. Beauchamp, and E. E. Robbins. Space 240.

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Minneapolis & St. Louis Locomotive No. 624 equipped with a boiler jacket of stainless steel—Photographed by M. C. Wallace, draftsman, M. & St. L., at Minneapolis, Minn.

EDITORIALS

S. 2009 Becomes a Law

On September 18 President Roosevelt signed S. 2009, the Wheeler-Lea omnibus transportation bill. It thereby becomes the Transportation Act of 1940. It is doubtful if any law passed by Congress has received so much study and discussion as has this act.

There are some things about its checkered career in the legislative mill that do not reflect credit upon the parties involved and possibly had better be buried and forgotten, that is, so far as public discussion is concerned. It is a step forward and that is about as much as can be said for it, so far as the railroads are concerned. It does place the regulation of the waterways under the Interstate Commerce Commission. It also provides, among other things, for the setting up of a three-member board to study the transportation problem. This in the long run may influence additional legislation which will tend to protect the railroads from the subsidized competition of other forms of common carriers and to relieve them of some of the unfair handicaps to which they are now subjected. Possibly it was expecting too much, with world affairs and national politics as they now are, to have a greater step taken in the right direction at this time.

Convention Attendance— Asset or Liability?

On October 22-25, inclusive, the four so-called coordinated associations will hold their annual conventions at the Hotel Sherman, Chicago. The value of a trip to the meeting of his association will be greatly enhanced for each supervisor this year by a large and varied exhibit of car and locomotive appliances, shop equipment, and maintenance materials. Indeed, for those who do not have to travel too far, a trip to Chicago during these meetings would be justified alone by the opportunity to study the displays of the more than 100 exhibiting concerns.

Personal Value to the Supervisor

But the exhibit is an incidental benefit and not the main reason why there should be a large attendance of officers and supervisors from the fields served by the four associations. Those men whose hope for the future lies in their understanding of and their ability to cope with the problems of utilization, operation, and maintenance of locomotives and rolling stock have a strong personal motive for seeing that they get to these meetings. Nowhere else can they so quickly have their preconceptions confirmed, modified, or knocked out of their heads as at a meeting which brings together the varying viewpoints and different backgrounds of experience of men all dealing with the same basic problems. Only after one's own ideas have been tested and modified by a thoughtful weighing of conflicting viewpoints does one arrive at the beginning of understanding. And if understanding is the beginning of wisdom certainly, to one who knows how to take advantage of his opportunities, convention attendance may be a very definite aid to the attainment of wisdom.

There are many who would place the attainment of wisdom above all other objectives, even above advancement by promotion. With it comes an appreciation of one's limitations as well as of one's capacities which one must have if he is to make the most of himself.

Another reason why the ambitious supervisor should get himself to his convention lies in the distinct opportunities which convention work offers for the development of such qualities of leadership as he may possess. At home the supervisor exercises authority in the performance of his duties. In convention work he is associated with his equals. What he is able to accomplish depends entirely on how effectively he can work with them and, on occasion, influence them to his own point of view. The ability thus developed over the years of convention work has broadened and advanced the careers of many men.

What Return Do the Railroads Receive?

But most of the men who attend these conventions are sent by their managements. At this point some readers are asking why the railroads should send their supervisors to conventions for the purpose of advancing their personal ambitions. Let us leave that question for the moment and consider convention attendance more strictly from the viewpoint of the management.

The educational value of convention attendance has been stressed whenever the subject has been under discussion in these columns. Men acquire a wider knowledge of accepted practices and learn the relationship between tools and methods in the reports presented at the conventions and in the discussions both on and off the floor. This is the most obvious function of association work.

Of equal value from the standpoint of the employer, though less tangible and, therefore, more difficult to appraise, is the inspiration which men get from convention attendance. When one returns from a convention at which he has listened to the best thought and

a compilation of the best practice for dealing with problems which are his own and—better yet—in the study of which he has contributed either on the program itself or by the expression of his own thought in the discussion, he approaches the every-day duties of his job with a renewed energy, a broadened outlook, and a stimulated mind. Though these qualities are intangible when one attempts to evaluate them in terms of dollars and cents, it is not difficult to see how they may return far more than the expense involved in sending men to conventions in the effectiveness with which men meet emergencies and, in the alertness with which they initiate new and more economical methods in their departments.

The Highest Return—The Development of Men

If there is a question in the minds of some of our readers why the railroads should send supervisors to conventions in order to advance their own personal ambitions, it may well be asked in reply what more effective means can the railroad employ to enhance its own return from the services of these men than by making them more valuable. The more valuable they are to themselves, certainly the more they are worth to the employer.

The greatest return to the railroads from the convention attendance of their men comes from the qualities of leadership, the widened outlook, and the surer judgment which men acquire through convention contacts.

Shop Employment and National Defense

As our program of national defense begins to take shape, it becomes more evident that one of the disturbing shortages which must be dealt with is a lack of sufficient men trained in the skilled trades. In an address before the National Convention of the American Legion on September 23, William S. Knudsen, chairman of the National Advisory Defense Commission, called particular attention to this shortage as a factor in holding back the nation in training a large modern army.

The mechanical departments of few railroads have ever completely recovered from the disrupting effects of the long depression. Employment of equipment-maintenance forces, particularly those in the back shops, is still intermittent in too many instances—long shut-downs may break the continuity of employment several times a year. With the improvement in traffic which has been shown so far during this year, the frequency and extent of such shut-downs has been considerably reduced. From now on, whenever shut-downs seem to be necessary, the railroads are facing a dilemma. The mechanical-department officer who assumes that he has any claims on men while they are laid off is likely to be rudely awakened when the next call for a return to work goes out. Industry is grabbing the cream of railway mechanics as opportunity offers.

This change in the demand for certain classes of labor is giving point to the serious need for the development of some plan for stabilization of employment in railroad shops. It is true that the railroads are without control of their volume of production. They are at the mercy of the fluctuations in commerce and in industrial production which they do not control. Since ton-miles must be consumed as produced, little can be done to stabilize employment in the train services. This does not hold true, however, for maintenance employees. It is possible for the management willing to tackle the problem with determination to smooth out the most of the month-to-month fluctuations in shop employment. Year-to-year adjustments will still be necessary, but with the elimination of the more frequent fluctuations most employees might again come to regard their jobs as possessing a reasonable degree of permanency. The alternative to some such solution is likely to be the loss of skilled labor to industries involved in our national defense program.

Related to the question of the conservation of present employees is the almost equally acute question of the training of men for manning the shops in the future. Railway employees are growing old. Even though the situation were not aggravated by losses to industry the need for the injection of young men into the organization is rapidly becoming acute. Every mechanical department at present without an adequate apprenticeship system which involves theoretical training and mental discipline as well as shop training, should be planning to install one without delay. The alternative may be a further encroachment of government subsidy —and control—to include the railroads in its schemes for recruiting industry.

Magnaflux Testing

The rapid extension of Magnaflux testing in railway locomotive and car shops throughout the country affords convincing evidence of the effectiveness of this method of locating defects such as progressive fractures, external grinding cracks, internal shrinkage cracks, slag pockets, etc., in steel parts before these defects have developed to such a point as to cause service failures with the attendant costly interruption of service, damage to equipment and possible loss of human life. The prevalence of modern high operating speeds creates an increasingly urgent demand for reliability in steel locomotive and car parts and it can hardly be questioned that, in the detection of potentially defective axles alone, this new method of testing has more than justified itself.

Magnaflux testing equipment and methods have been

described quite fully in previous issues of *Railway Mechanical Engineer* and yet it is obvious that neither the fundamental advantages nor limitations of this new method of testing are always clearly understood, judging by questions asked at a recent southern railway club meeting at which this subject was discussed. For example, the first question related to the direction of a crack which can be detected by the magnaflux method and the answer was that the transmission of an electric current of large amperage and low voltage through a cable, wound around the steel parts being tested, induces a strong magnetic field lengthwise of the part and any transverse crack interrupting the lines of flux will be indicated at the surface by the adhesion of dry Magnaflux powder to the crack when the part is vibrated. To locate a longitudinal crack in a part such as a car axle, the electric current is passed directly through the axle, itself, which serves as a conductor and gives a circular field of flux lines which would be crossed by any longitudinal discontinuity. Obviously, therefore, the Magnaflux machine provides inspection primarily in one direction at a time.

Another question relating to the possibility of discovering internal defects is answered by the fact that by far a great majority of all cracks in steel parts originate at the surface and hence give an indication when tested by the Magnaflux method. It is said to be a fact, however, that sizable internal fractures such as shrinkage cracks in steel castings can be detected if they extend within ¾ in. of the surface and the proper amperage of direct current is used. In response to a query, the statement was made that the Magnaflux powder used in this testing method is pure iron, the most highly permeable metal available, and hence the one which responds most freely to flux leakage.

In discussing the question of whether the introduction of the Magnaflux testing method does not tend to cause the scrapping of an undue number of locomotive and car parts due to the discovery of small defects, it was said that the conditions causing these defects may in most cases be corrected and many of the parts themselves returned to service by a little judicious reconditioning work. The experience was cited of one railroad which developed an alarming number of defects and replacements on the first shopping of locomotive parts after introduction of the Magnaflux method, these replacements on the second shopping being substantially reduced and on the third or fourth, the indicated defects reached a gratifyingly low point.

Obviously, under present conditions, the Magnaflux method can give no indication of a car axle crack, for example, entirely within the wheel fit and, in some instances, wheels have been pressed off about 1 in. so as to give an indication or check of this part of the wheel seat where fractures usually occur. If none is found the wheels are pressed back on again, due precautions being taken to assure that correct mounting pressures are maintained. Intensive research is being conducted in this and associated problems, as it is realized that there is great need for a testing method which will indicate defective parts in railway cars and locomotives without the delay and cost of shopping the equipment and removing the parts for separate, individual tests.

New Books

MACHINE SHOP TRAINING COURSE. *By Franklin D. Jones. Two Volumes, 6 in. by 9 in. Volume 1, 474 pages; Volume 2, 552 pages. Published by The Industrial Press, 148 Lafayette St., New York. Complete two-Volume course, $6; Volume 1 or Volume 2, $4, if purchased separately.*

The Machine Shop Training Course covers both elementary and advanced machine shop practice. Volumes 1 and 2 may be used independently, each covering about half of the subjects dealt with in the complete two-volume treatise.

The first volume begins with fundamental principles underlying all metal-cutting operations, and continues with various branches of lathe work. Then follows the general application of turret lathes and automatic machines; drilling, reaming, and boring, including precision jig boring; drill grinding; the use of tolerances and allowances in interchangeable manufacture; and, finally, the various types of measuring and gaging tools, with typical applications.

The second volume deals with such subjects as tapping, thread cutting with dies, thread milling, thread grinding, and thread rolling; planing practice; milling, including the milling of irregular contours by reproducing the shape of a model; different systems of indexing; gear-cutting on milling machines; gear-cutting by generating methods, featuring the basic principles; external and internal grinding; lapping, broaching, chipping, filing, and scraping; tool steels and other metal-cutting materials; and the heat-treatment of tool steels.

Questions have been used throughout the work instead of ordinary sub-heads because of their interest-stimulating value. These questions are followed by complete answers averaging about one page in length. Definitions of 330 shop terms in general use occupy 48 pages at the end of Volume 2.

The Machine Shop Training Course not only explains how, but gives the reasons why. For example, the four sections or chapters on the use of measuring instruments and gages are preceded by two sections explaining why the degree of accuracy is controlled in interchangeable manufacture, and why different classes of fits are employed and have, to some extent, been standardized. This general method of treatment is followed throughout.

The treatise not only deals with all standard types of machine tools and illustrates their use by typical applications, but it includes numerous shop problems with complete solutions.

The information on the details of machine shop practice is supplemented wherever necessary, with explanations of whatever mechanical principles may be directly allied to the subject.

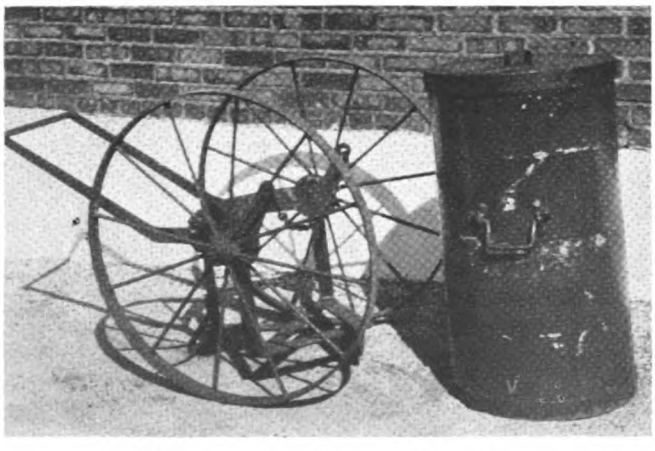
With the Car Foremen and Inspectors

Combating Fly Nuisance At C. & N. W. Coach Yard

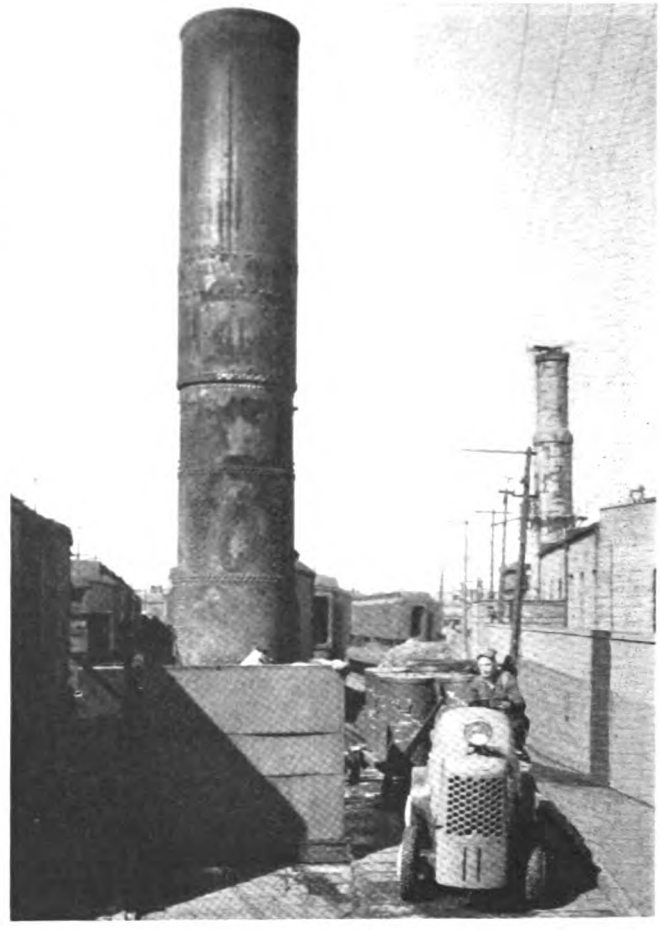
An unusually efficient and sanitary method of garbage disposal has been developed and is now in use at the California avenue, Chicago, coach yard of the Chicago & North Western. As compared with the former method of removing garbage from diners, club cars and private cars received at California avenue yard by means of open wheelbarrows, the new method utilizes covered containers with suitable hand cart and power facilities for moving them, so that the nuisance incident to handling garbage about the yard is entirely overcome; flies, rats, mice and bad odors are materially reduced; and an important saving is made in the actual labor of removing the garbage.

Special equipment used in this new method of garbage handling and disposition includes 16 large portable sheet-metal containers built at the local car shops, a two-wheel hand cart of special design for easy movement of individual containers about the yard, a trailer truck and depressed platform or pit centrally located for the accumulation of garbage containers, and a Hebbard gasoline shop mule or tractor which hauls the trailer loaded with eight containers to the incinerator at one side of the yard. The garbage container is made of 20-gage galvanized iron, 21 in. in diameter by 36 in. high, equipped with two handles and a flanged cover made of ⅛ in. steel. This container is fabricated by welding and relatively inexpensive to make.

The two-wheel hand cart for moving individual containers also is illustrated. It consists of two 36-in. wheels mounted 27 in. apart on a light steel frame built up of welded ⅜-in. by 2-in. and ⅜-in. by 3-in. strap steel and designed so that, by raising the handle and tipping the barrel slightly, the lower part of the frame readily slides under the base of the barrel which can be tipped in place against a half-round section of the frame and held by means of a safety chain. The frame of this cart is designed so that, with the loaded container in place, it is well balanced and very little pressure is necessary on the cart handle to keep the container in a vertical position while moving about the yard. The base of the cart frame is designed with two stops, front and back, so that when the handle is released the container cannot tip over in either direction. One of the illustrations shows a container mounted in the two-wheel cart and properly positioned at the dining-car door so that the diner garbage can be emptied into it easily and without danger of spilling anything on the ground. The garbage-can cover is shown resting temporarily on the handle of the cart.

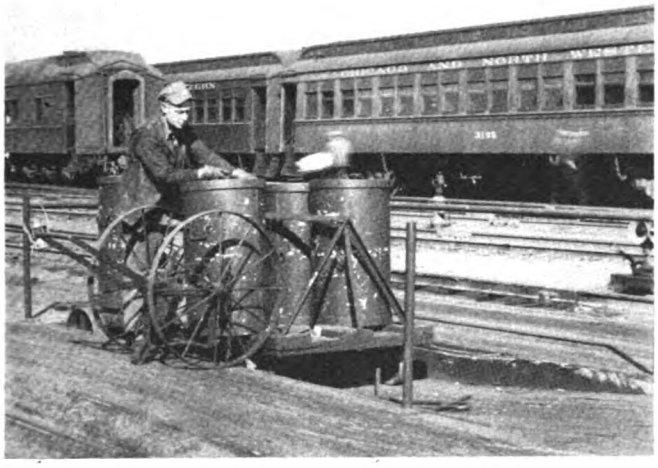


A single container and the two-wheel hand cart



The trailer truck spotted ready for unloading at the incinerator

The trailer truck used in moving one or more garbage containers by means of the shop mule, consists of a low-wheel trailer 8 ft. long by 4 ft. wide and 14 in. high. The upper surface is covered with galvanized iron to reduce friction in sliding containers on and off. A ridge pole made of 1½-in. angle iron is supported 27 in. high by diagonal angle iron braces, as illustrated. This ridge pole, removable to facilitate loading the entire truck from either side, is equipped with short safety chains for attachment to the garbage container handles as a safety measure against their being jounced off the truck during



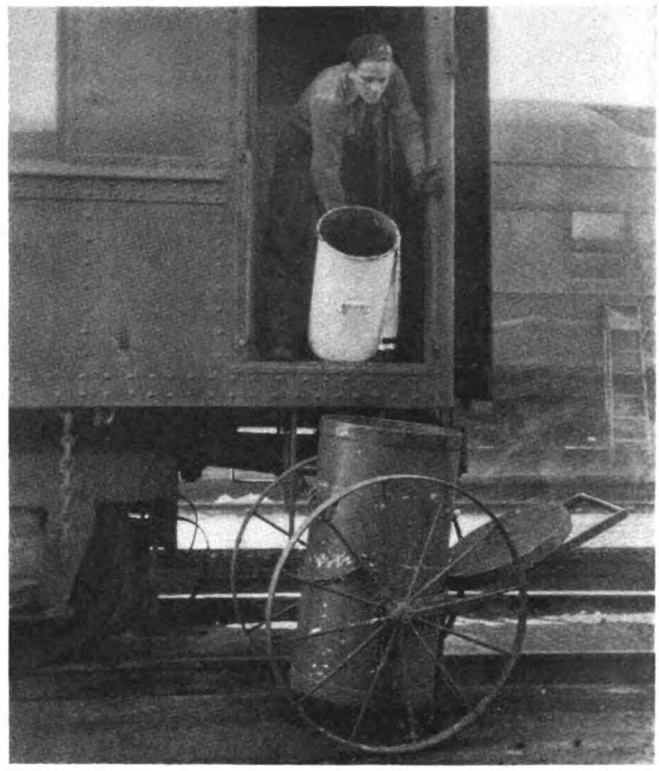
Placing a container on the trailer at the loading pit

movement over roadway which may be rough in some places. The two front wheels of the truck are, of course, arranged to swivel and a have a T-handle tongue with a ring for attachment to the tractor.

The centrally located loading pit consists of a depression in the wood walkway, 5½ ft. wide by 8 ft. long by 10 in. deep, with an inclined approach, also about 8 ft. long, up which the truck is pulled by the shop mule. The pit is surrounded by a 1¼-in. pipe guard, the horizontal side pipes being 37 in. high and arranged to be removable on either side when loading the truck. The use of this pit brings the top of the truck to practically the same level as the garbage container bottom when transported in the two-wheel truck, so that very little manual labor is involved in disconnecting the safety chain and pipe and sliding the barrel onto the trailer truck.

The incinerator, located on the outskirts of the yard, consists of a scrap locomotive boiler, up-ended on a suitable concrete foundation and equipped with a stack extension bolted to the smoke box to give the required additional draft. A sheet-metal door is applied to cover the firebox opening at the elevated platform level and there is a cinder pit beneath the platform for the removal of ashes. The platform also carries a sheet-metal temporary garbage storage bin into which the garbage is dumped from the containers and then shoveled into the incinerator for burning and final disposition.

By the new method of handling, kitchen and pantry garbage cans on all diners and other cars received at California avenue yard are emptied into a garbage container by the car cleaner, who moves the container when full to the centrally-located loading pit and places it on the trailer truck. When eight containers have been accumulated, the shop mule is used to haul the trailer to the incinerator. The containers are kept covered at all

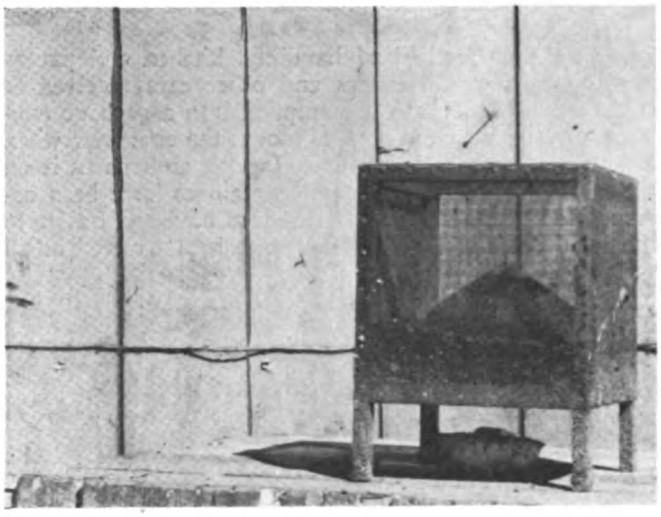


Emptying a diner garbage can into one of the containers

times and after being emptied at the incinerator are steamed out and returned to the pit ready for reloading. This positive prevention of the spilling of garbage and refuse when unloading into wheelbarrows and in movement through the yard has been surprisingly effective in largely eliminating flies, odors and rodents and has



Moving a trailer with eight garbage containers out of the loading pit



Simple but highly effective type of fly trap used at the incinerator

greatly improved the working conditions throughout the yard. In addition, the mechanical handling of the containers in multiple on the trailer has saved extra trips and reduced manual labor, it is estimated, about 50 per cent.

To take care of what few flies are unavoidably present around the incinerator, an ingenious fly trap is utilized, as shown in one of the illustrations. This trap consists of a 12-in. square wooden frame mounted on four short legs and having flat screen sides and top with a cone-shaped bottom, extending upward into the box and having a small hole at the top. An aged half cantaloupe, or other bait, placed under the trap, serves to attract the flies, which when startled fly upward to the cone and work through the hole in the top into the trap. Here they subsequently pass away of malnutrition or are killed by momentary insertion of the trap in the hot gasses of the incinerator. The trap is emptied by removing the screen on the top. A few traps of this kind are all that are now required around the incinerator, whereas formerly they had to be distributed quite generally throughout the entire coach yard.

Handling Device for Punching Steel Plate

In Fig. 1 is shown a handling device that has been recently installed on a punch in the Erie car shop at Port Jervis, N. Y. With this additional equipment one man is enabled to punch holes in steel plate more accurately and safely than was possible before the installation of this equipment. It is designed to handle either small or large pieces of steel plate.

The device was fabricated by electric welding mostly from available scrap material. In fact, the five 1¼-in. steel balls on which rests the plate to be punched are probably the only pieces of material that could not readily be found in any railroad-shop scrap pile. These ball bearings are supported by solid vertical rods that have been cupped out at the end and in which the bearings rotate freely in any direction. These vertical supports are held rigidly in position by frames, built of ¼-in. plate by welding, and bolted to the bed of the punch. The two front bearing supports, on either side of the dies, may be moved in a vertical direction by means of a foot pedal, connecting rod, and levers. A removable fixture, resting on the two front bearings and with an opening cut out for the dies, permits plate to be handled of less width than the distance between the two bearings.

In Fig. 2 is shown the first step in the punching of small steel plate. It can be seen that the bottom of the

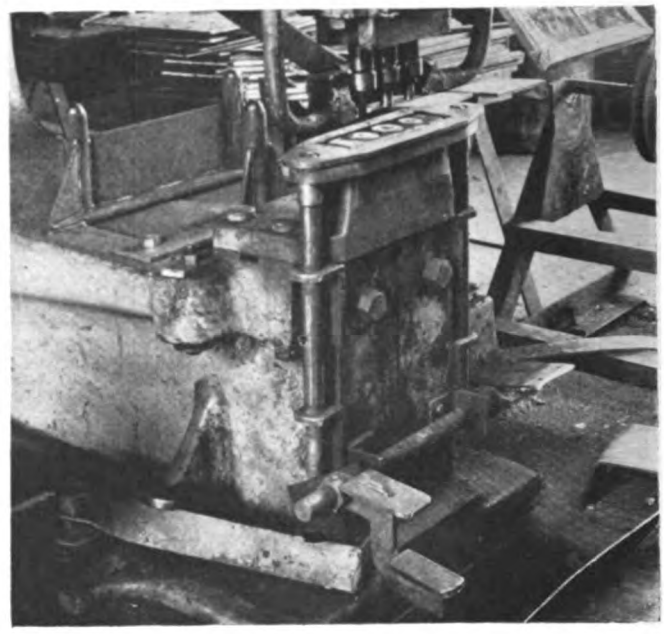


Fig. 1—The steel-plate handling device installed on punch

punch is approximately one inch away from the plate as it rests on the die. In this position it would be necessary for the operator to guess at the relative location of the punch and the center-punch mark on the plate. In-



Fig. 2—Small pieces of steel plate are supported by the fixture resting on the two front bearings



Fig. 3—The plate is elevated up to the punch by movable front bearings operated by a foot pedal

stead of guessing, the operator can raise the plate up to the punch, as shown in Fig. 3, and accurately center the lay-out mark with the punch by merely pressing down on the foot pedal with his left foot. While holding the work in this position, he trips the punch with his right foot.

Steel plate of large area is shown in Fig. 4 supported by all five bearings. This large plate can be moved easily in any direction and, if it extends in front of the punch too far, it can be raised by operating the foot-

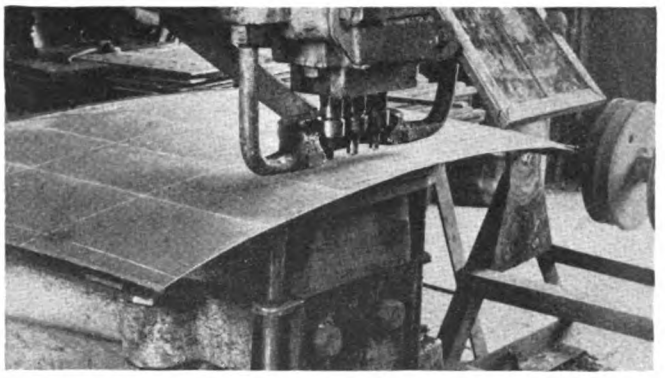


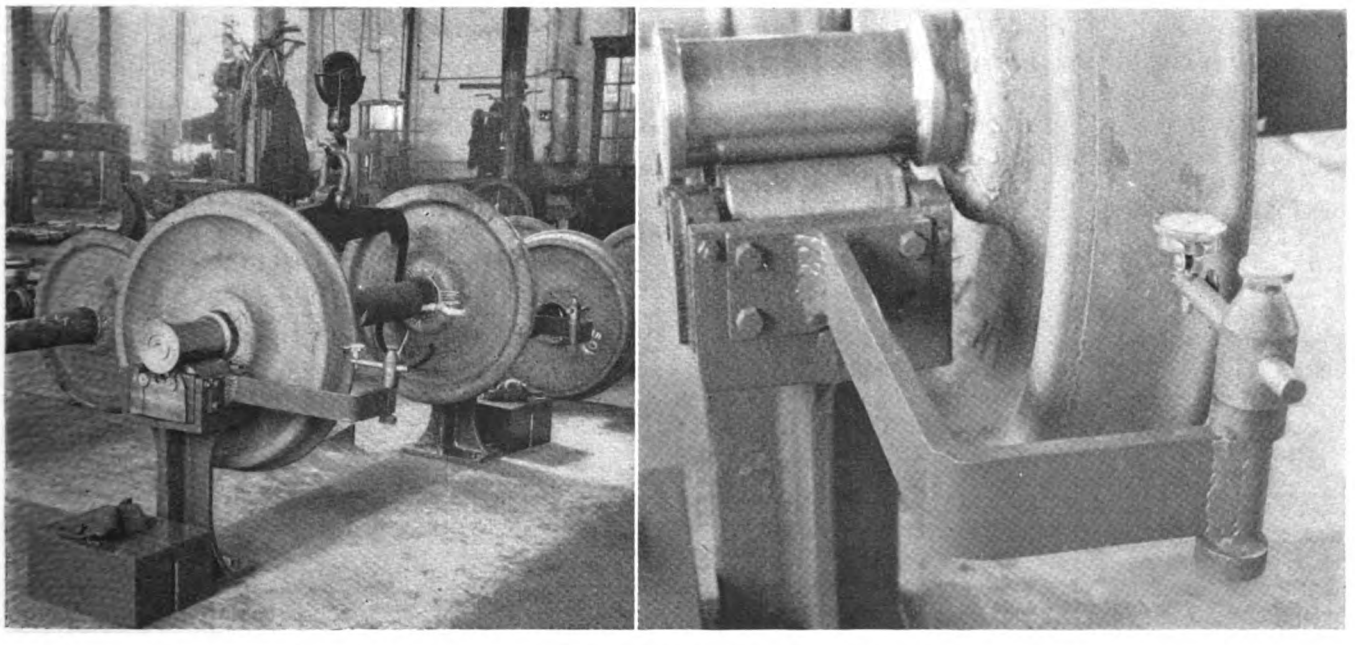
Fig. 4—Steel plate of large area is easily moved in any direction when supported by the five ball bearings

pedal extension shown in Fig. 1. During any of these operations it is unnecessary to have the hands near the moving punch while completing the job.

Device for Checking Wheel Concentricity

The equipment shown below was developed for checking the concentricity of mounted wheels for freight and passenger cars and locomotive tenders—either cast iron or wrought steel. At the left is shown the two floor standards in which are set two large, finely finished rollers. Attached to each standard is a bracket at the end of which is an attachment holding a bar for a dial gage.

The photograph at the right shows the manner in which the dial gage is mounted and, in this case, it is being used to check the tread of the wheel. The revolving head at the end of the bar makes it possible to check other points, such as the flange of the wheels. This device is used, in the shop where the photographs were taken, to check a certain number of mounted wheels each



Part of each day's output of wheels is checked for concentricity with this device

day as they come from the mounting press in order to assure proper mounting as well as a check against the accuracy of the boring mills on which the wheels are bored.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Car Damage— Not Subject to Rule 44

On March 6, 1938, the Philadelphia Quartz Company's empty tank car 510 was inspected and humped at the Cedar Hill, Conn., yards of the New York, New Haven & Hartford. It was then repaired at this point, because a coupler head and both center pins were broken, the side-bearing rollers were missing and the car was off center at both ends. The N. Y. N. H. & H. rendered a bill to the Philadelphia Quartz Company to which it took exceptions, claiming rough handling. The Philadelphia Quartz Company maintained that the car was improperly handled in the Cedar Hill yards as this car had been accepted by the N. Y. N. H. & H. on March 2, 1938, and, therefore, the railroad was liable either for the damage incurred or else for having accepted the car in bad condition at an interchange point. According to the investigation made by the N. Y. N. H. & H., the car was not subjected to any rough handling per A. A. R. Rule 32 nor was there any indication of the car being derailed, cornered or sideswiped.

In a decision rendered November 16, 1939, the Arbitration Committee stated: "From the evidence submitted the damage is classifiable as car owner's responsibility under the provisions of Rules 32 and 44. The contention of the Philadelphia Quartz Company is not sustained."—*Case No. 1777, Philadelphia Quartz Company versus New York, New Haven & Hartford.*

Owner Responsible for Damage Caused by Couplers Passing

Chicago Great Western all-steel box car 87800 was damaged while being switched in the Missouri Pacific yards at Kansas City, Mo., on July 20, 1938. The M. P. made repairs for safety appliance defects for which they billed the C. G. W., and then delivered the car to the C. G. W. at this point with several defects still in existence. A defect card was requested by the C. G. W. on the basis of paragraph (o-2), section 10 of A. A. R. Rule 32. The M. P. declined to accept responsibility, contending that the damage was due to the couplers passing and therefore was the car owner's responsibility. The C. G. W. cited the statement in Rule 32 that the handling line is responsible for the end of car body above the underframe being broken or bent inwardly when not associated with failure of the end sill on the same end. This road also contended that the damage to this car could not have been caused entirely by the couplers passing as photographs indicated that the end of this car was struck by the end of the adjacent car in switching. The M. P. maintained that no cars were derailed, cornered or side swiped nor was section o, Rule 32 applicable as it contended that paragraph 2, section (o) of this rule could not be separated from the rule proper to apply in a case of this kind. The M. P. also called attention to the fact that the damage to the car end had not occurred without damage to the end sill, consequently there could be no claim of telescoping and neither could the operation or damage be classed or considered as cornering.

In a decision rendered April 11, 1940, the Arbitration Committee stated: "No evidence is offered to disprove the statement of the handling line that damage was caused by couplers passing while the cars were on the same track. The car owner's claim of unfair useage is based on the wording of Rule 32, paragraph (o-2), construing this to mean that damage to such an extent is a handling-line responsibility regardless of circumstances. Such an interpretation is erroneous for the reason that the passing of couplers when cars are on the same track can cause damage to the superstructure. The contention of the car owner is not sustained."—*Case No. 1778, Chicago Great Western versus Missouri Pacific.*

Air Brake Questions and Answers

D-22-A Passenger Control Valve (Continued)

606—*Q.—Is the retaining valve connected directly to the brake cylinders with the D-22-A equipment?* A.—The retaining valve is connected to the displacement reservoir in release position of the control valve and controls the release of the brake cylinder pressure through the operation of the relay valve.

607—*Q.—When releasing the brake, at what place in the control valve equipment does the brake cylinder air flow to the atmosphere?* A.—Through the exhaust port of the relay valve.

608—*Q.—What apparatus is used to make a test of the car brakes for the car only?* A.—An apparatus known as the single-car testing device (passenger).

609—*Q.—What pressure is required in the supply line when making this test?* A.—At least 70 lb.

610—*Q.—What must always be done before attaching the test apparatus to the supply line?* A.—Blow out line to get rid of condensation and any foreign matter.

611—*Q.—After coupling the apparatus to the supply line and before coupling to the brake-pipe hose what should be done?* A.—Move the handle on the device to position No. 3 (lap), and open the cock in the supply line. There should be no escape of air from the brake-pipe connection of the testing device or at the exhaust port. If a blow exists, the testing device should be replaced by one in good condition.

612—*Q.—What should be done after it has been ascertained that the testing device is in good condition?* A.—Connect the end marked *BP* to the brake-pipe hose at one end of the car. To the other end of the car couple on a dummy coupling. Open both anglecocks, move the handle to position No. 1 and charge the brake pipe and reservoirs to 70 lb.

613—*Q.—What is the first test?* A.—The application test.

614—*Q.—How is this test made?* A.—Move the device handle to position No. 3 (lap) for five seconds to determine if the equipment is fully charged. With the equipment charged to 70 lb., move the device handle to position No. 5 for 1 to 2 seconds, and then move it to position No. 4, reducing the brake-pipe pressure 10 lb., then slowly return the handle to lap position. Note that the brake-pipe pressure does not continue to drop and that the brake applies.

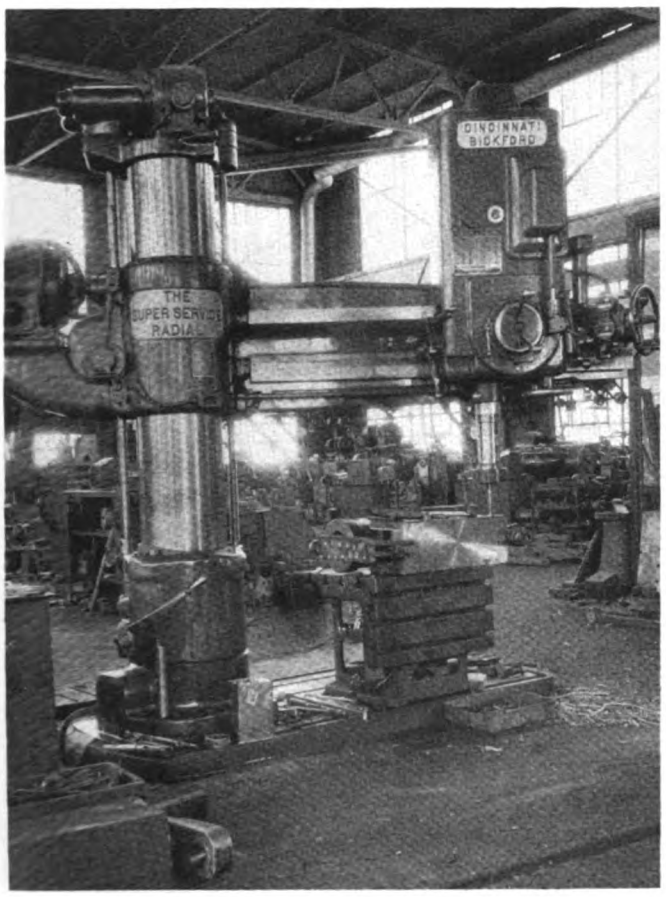
IN THE BACK SHOP AND ENGINEHOUSE

How the Small Shop Performs Driving-Box Work

In the large shop, where the output of classified repairs may run from 30 to 45 locomotives a month, the work of manufacturing and repairing driving boxes is a specialized job. Considerable thought has been given to the arrangement of facilities in a department devoted entirely to this class of work and such a department is usually self-sufficient in the matter of machine tools, furnaces for melting, and parts-handling equipment. The driving-box department of a large shop naturally presents a problem to the supervisor in charge but it is one of eliminating lost motion and keeping production at a maximum.

At the other end of the scale the driving-box job in a small shop presents just as difficult a problem to the supervisor of that shop, for there is no driving-box department as such, no departmental foreman and the machines and equipment used for the work are the same one that have to perform a multitude of other jobs related to locomotive repair work. The manner in which such work is carried out at the Pen Argyl, Pa., back shop of the Lehigh & New England is an excellent example of small-shop operation and is the basis of this article.

The entire motive-power inventory of the L. & N. E. comprises 47 units of four types: Six-wheel and eight-wheel switchers, Consolidations and Decapods. The locomotives are given general repairs at the Pen Argyl shop at the rate of from 12 to 15 locomotives annually. The driving-box work, therefore, in connection with locomotives going through the shop, involves only about 100 to 140 boxes a year, or an average of less than 12 a month. Obviously, there is no opportunity to specialize the work and it is, therefore, a problem of fitting it in with the other work of the shop.



Among numerous other jobs, crown-brass dowels are drilled out and new brasses drilled for dowels on this radial drill



Worn driving boxes are trued on the planer preparatory to welding on steel shoe and wedge liners

There are no specialized machines and the machines used on this work perform many other locomotive machining operations. Such units at Pen Argyl are listed in Table I.

Some idea of the size of the driving boxes used on the L. & N. E. power may be had from an examination of Table II which shows the driving journal size of four types of locomotives, limits of wear and general dimensions of the largest and smallest box used, as examples.

In view of the fact that the machine-tool units must handle a great variety of parts, mostly in small lots, it is not possible to locate machines to the advantage of any one class or work. Yet, so well arranged is this nine-pit, transverse shop within a 163-ft. by 264-ft. building (housing machine, erecting, boiler and blacksmith departments) that a set of boxes moves only approximately

Table I—Type and Age of Machines Used on Box Work

Name of Machine	Age of machine, yrs.
600-ton Southwark hydraulic wheel press	24
25-in. Lowell vertical slotter	24
5-ft. Cincinnati-Bickford radial drill	3
52-in. King boring mill	3
36-in. by 10-ft. Gray planer	16
30-in. by 84-in. Shipley planer	28
Brass melting furnace — Johnson	10
16-in. Lodge & Shipley engine lathe	24

Table II—Characteristics of Driving Boxes on the L. & N. E. Locomotives

	Journal size, in.		Allowable reduction in journal diameter, in.		Principal Dimensions of Boxes*					
	Main	Others	Main	Others	Extreme height of box, in.	Extreme width of box, in.	Hub face diam., in.	Distance between toes, in.	Shoe and wedge face width, in.	Rock in shoe and wedge flanges, in.
0-6-0	9 × 12	9 × 12								
	10½ × 13	10½ × 13	½	¾	....	....	..	....	....	.....
0-8-0	10 × 12	10 × 12	½	¾	....	....	..	....	....	.....
	12½ × 14	11 × 14	½	½	....	....	..	....	....	.....
2-8-0	8 × 8½	8 × 8½	½	¾	....	....	..	....	....	.....
	8 × 8½	7½ × 8½*	½	½	18¼	15½	15	8	$5\ ^{21}/_{32}$	⅛ in. 12 ¼ in. straight
	10 × 10	9 × 10	½	¾	....	....	..	....	....	.....
2-10-0	13½ × 14*	11 × 14	½	½	27⅜	27¼	26	14¼	$9\ ^{1}/_{16}$	⅜ in. 12 2 in. straight

* Dimensions of smallest and largest box handled as a typical example.

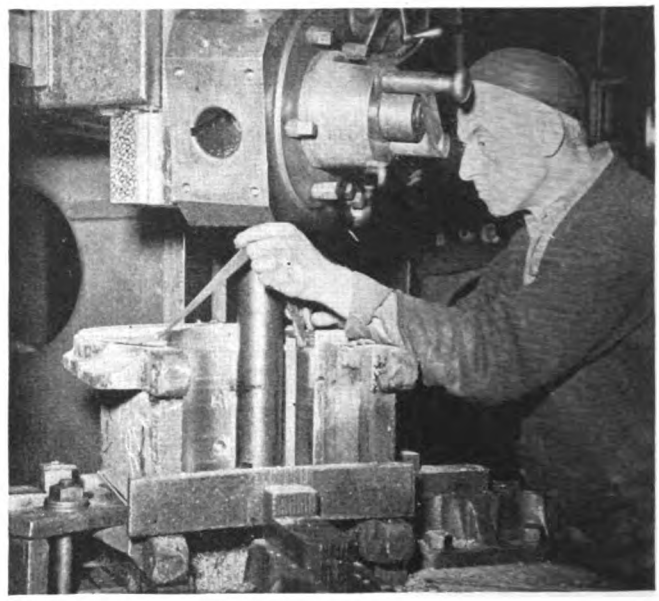
1,150 ft. in passing through all of the operations shown in Table III, from the time of removal from a locomotive to re-application.

The shop is equipped with a Whiting 200-ton hoist on No. 1 erecting pit which handles all but the lightest locomotives. The erecting bay is served by a 35-ton Whiting crane with 10-ton auxiliary hoist. When a locomotive is unwheeled, the boxes are removed and placed in a metal basket at the cleaning vat located adjacent to pits No. 1 and No. 2. Here they are cleaned with Oakite No. 22 and sent to the 52-in. King boring mill where the hub liners are cut off, thence to a 5-ft. Cincinnati-Bickford radial drill for drilling out crown-brass dowels. The brasses are inspected for looseness and wear and, if they must be removed, go to the 600-ton Southwark press. The maximum allowable wear is ⅜ in. to ½ in. below original. New crown brasses are turned on the boring mill, sent to the 27-in. by 84-in. planer to have the toes planed and back to the 600-ton press where they are put in the boxes. Then the boxes go to the radial drill for the redrilling of hub-liner dowels, after which they are sent to the smith shop for pouring the hub liners. The brass is melted in an oil furnace with a 9-in. by 12-in. crucible. This will heat enough metal for four small or three large boxes. Old brass is remelted for this purpose.

If new shoe- and wedge-face liners are needed, the faces are trued up on a planer and steel plate liners welded on. Welded steel liners are also used on driving-wheel hubs. As an example, a box which was 11½ in. over shoe and wedge faces when new receives $^{5}/_{16}$-in. liners when worn to 10⅞ in.

The shoe and wedge faces are then trued up on the planer so that the bore is central and the shoe and wedge faces parallel. The toes of these boxes spread as much as $^{1}/_{32}$ in. to $^{3}/_{16}$ in. in service.

New dowel plugs are made on an engine lathe and after the holes have been redrilled, the new brasses and the plugs are driven in and the boxes go to the King mill for boring the brasses and facing the hub liners. One illustration shows the method of centering the box on the boring-mill table. The marking gage shown is used to scribe off, on the brass, the location of shoe and wedge faces. These faces having been previously planed equidistant from the box center line, and parallel, the pointer on the tool post indicates which way the chuck jaws should be moved to center the box.

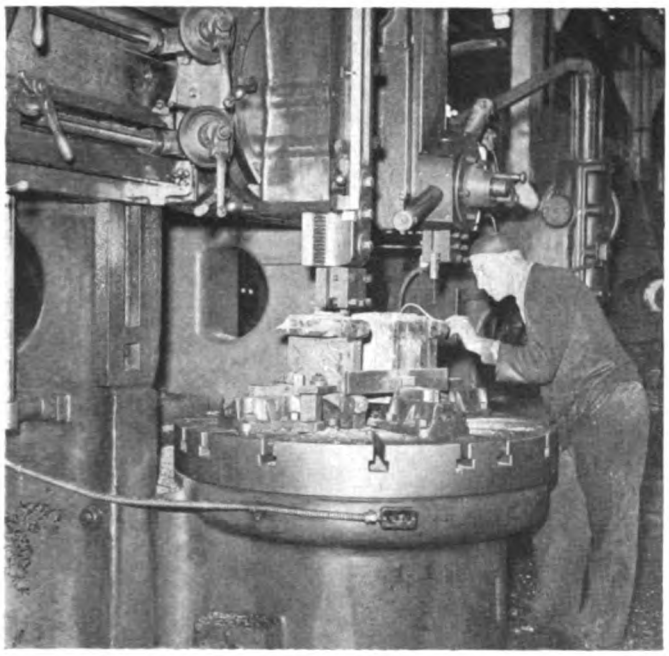


Gage used in centering the driving-box on the boring-mill table

Table III—Driving-Box Operations at Lehigh & New England Shop, Pen Argyl, Pa.

Operation	Machine Used	Operation Time, Per Box, Except As Noted: Small Boxes	Large Boxes
1—Remove boxes		4 hr. (8 boxes)	8 hr. (10 boxes)
2—Metal basket to cleaning vat		2 hr. (8 boxes)	2 hr. (10 boxes)
3—Clean with Oakite No. 22		6 hr. (8 boxes)	8 hr. (10 boxes)
4—Cut off hub liners (cast brass*)	52-in. King boring mill	30 min. per box	40 min. per box
5—Drill out five or six dowel holes in hub face dovetail	6-ft. Cincinnati-Bickford radial drill	20 min.	20 min.
6—Inspect for loose brass or crown wear		30 min.	40 min.
7—Press out old brass, if necessary	600-ton wheel press	15 min.	20 min.
8—Turn outside of new crown brass	52-in. King boring mill	50 min.	70 min.
9—Lay out brass with three-point gage		10 min.	10 min.
10—Plane toes of brass in V-blocks	27-in. × 84-in. Cincinnati planer	45 min.	60 min.
11—Press brass in box	600-ton wheel press	20 min.	25 min.
12—Redrill dowel holes for hub liners	Cincinnati-Bickford 6-ft. radial drill	20 min.	25 min.
13—Boxes to smith shop to pour hub liners	Oil furnace with 9-in. × 12-in. deep crucible	60 min.	130 min.
14—Weld on new steel shoe and wedge face liners	Electric welder	40 min.	60 min.
15—Plane shoe and wedge face	Gray 36-in. × 10-ft. planer	120 min.	150 min.
16—Make two brass crown dowel plugs	Engine lathe	20 min.	20 min.
17—Drill crown brass for dowels and drive dowels	Radial drill	20 min.	25 min.
18—Bore brass and face hub liner	52-in. King boring mill	75 min.	150 min.
19—Fit grease cellars		30 min.	40 min.
20—Fit eight boxes to journals (one machinist, one helper)		12 hr. (8 boxes)	16 hr. (10 boxes)

* National Bearing Metals formula (same as journal brasses and crown brasses).



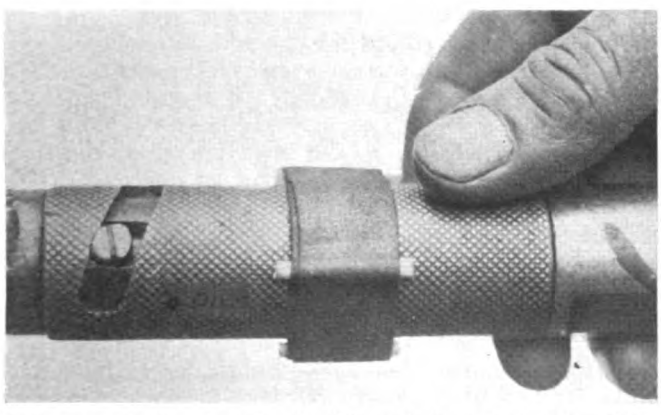
Hub liners are faced and bearings bored on the King boring mill—New crown brasses are also turned on this mill

When the set of boxes has been completed the cellars are fitted ($\frac{1}{64}$ in. loose) and they go to the erecting floor for re-application.

The time required for the several operations on large and small boxes is shown in Table III.

Emergency Grip for Air Motor Throttle

The knurled throttle sleeve on many pneumatic motors, drills, and other compressed air tools is often hard to keep regulated and operate with the precision required on many jobs. If the hands are moist or covered with a light film of oil or heavy gloves the throttle sleeves are not easy to grip or to turn slightly. By using some electricians insulating tape and several matches, the handy aid to the grip shown in the photograph can be made. Make one or two turns of the tape around the sleeve, then lay in three or four pieces of match or other small slivers of wood. Wind one or two turns of tape around them, pressing down firmly. This makes a number of ridges or humps, comfortable and easy on the fingers, yet affording an excellent grip on the throttle sleeve.



Emergency grip for air motor throttle made from tape and matches

This simple emergency grip is easily applied and removed when through using the motor.

Instructions for Maintaining Diesel-Electric Equipment

In the April issue of the *Railway Mechanical Engineer,* page 131, there appeared an abstract of a paper by H. V. Gill, supervisor of Diesel locomotives, Atchison, Topeka & Santa Fe, in which mention was made of an instruction bulletin issued by that road. That part of the bulletin pertaining to the Diesel engine was published in the May issue, page 202. The following is that portion of the bulletin relating to electrical equipment and lubrication.

Electrical Equipment

Inspection, Testing, Repair and Cleaning of Generators and Motors—Electrical equipment must be kept clean and dry to secure proper service without unnecessary expense. All generators and motors should be carefully inspected for loose connections; worn bushes; weak brush tension; loose or worn brush holders; eccentric or grooved or burned or dirty commutators; loose band wires; loose or broken fans. Any indication of excessive heat should be investigated. Any dirty or oily conditions should be corrected by wiping out oil or grease using clean dry rags. All wiring should be securely clamped to prevent chafing of insulation. Any chafed or worn insulation should be repaired at once to prevent grounds. Clean, dry air at pressure not to exceed 50 lb. may be used to blow out dust, etc., from motors and generators. Carbon tetrachloride, instead of gasoline, should be used for washing electrical equipment to eliminate fire hazard. Traction motors must be kept clean and in first-class condition to eliminate failures following the above practices. Particular attention should be given to prevent oil or water getting into the motor. Attention should be given to the traction-motor nose spring assembly and any excessive wear should be corrected.

High-Voltage and Low-Voltage Cabinets—These cabinets must be kept clean and dry—They may be blown out with clean, dry, compressed air. They should be examined for loose panels and poorly secured wiring, and any indication of the possibility of insulation chafing should be corrected. All contactors, reverse current relays, switches and resistance units should be examined for loose connections, burned or worn-thin contacts; proper contact tensions, proper air gap, proper wipe of contact and contact tips must fit together uniformly over the entire surface; moving parts of the contactors and switches must work freely. Where the contactors operate automatically the sequence of opening and closing should be checked. Control air lines and reversing valves should be tested to be sure they are clean and open.

Control Circuits—Control circuits should be checked for connections; worn insulation; dirty, oily condition or accumulation of water. Control circuits must be checked for proper sequence of operation of contactors and throttle control.

Main Contactors and Reverse—The main contactors are to be inspected for loose connections; worn parts; air leaks; sluggish operation; burned or worn thin contact tips and burned shunts. Main contactors must operate snappy and in proper order or trouble will result. The reverse must be kept clean—may be lightly lubricated with a light coat of vaseline or high-grade roller-bearing grease. Contact fingers must have the required

tension. Burned contact fingers or shunts or burned surface of the reverser drum should be corrected. All connections at the reverser must be kept clean, dry and tight.

Compressor Governor—The air-compressor governor should be thoroughly cleaned and tested for proper operation. Cutting-in and cutting-out pressures should not vary; if so, the sluggish condition of the governor should be investigated and corrected. Any report of erratic operation of the air compressor or the air-compressor governor must be investigated and corrected. Whenever the compressor is reported, or when it shows weakness at the time of the orifice test, the valves should be removed and the carbon accumulation cleaned out. Any defective parts or valves, such as unloading springs, unloading plungers, cages or seating springs, should be replaced. No carbon should be allowed to enter the cylinders.

When necessary the piston rings are to be renewed in the air compressor.

Check and Clean Electrical Grounds—All Diesel-electric locomotives are equipped with ground protective relays which will open up the power and control circuits if grounds exist. If the ground protective relay should not function quickly enough, the electrical equipment will be damaged. All grounds, or short circuits, must be removed or failures will result.

Head and Cab Lights and Engineroom Lights—Head and cab lights, and engineroom lights, must be maintained in good, safe operating condition.

Traction-Motor Cables—The traction-motor cables must be given special attention both inside and outside of the motors. Where the insulation is chafed or worn, repairs must be made and the condition which caused the chafing removed. All sharp bends should be avoided. When coupling up the traction-motor cable connectors, the connectors should be carefully taped over to prevent moisture from entering. Be sure the bolts that secure the two halves of the cable connectors together are tight.

Traction Motor-Drive Gears—The traction motor-drive gears on the motor and the axle should be carefully checked for excessive wear, broken or badly chipped teeth whenever the motor is removed. They should also be examined through the opening in the top of the gear case at least once a month for defects and lubrication.

Engineman's Control Station—This check should include an examination of the control stand; the control-station switches and the dead-man pressure-control switch. This inspection should be carefully handled. Check for loose connections, poor fuse clips, clean control-drum contacts, weak or worn contact fingers, wear-in throttle or connecting gearing. Test the dead-man pressure control switch for proper operation.

Batteries—Batteries should be kept clean and dry. Avoid overflushing, as the electrolyte will run out, causing grounds. Check the gravity on the road engines daily; on the switch engines, not less frequently than once a month. When the batteries are reported, a check of the charging equipment should be made for the proper charging rate and check for grounds.

Steam Generator Controls—The steam generator motors, the control panels and the wiring should be given the same servicing and inspection as the other contractors and the wiring in the power plant. *The safety devices should each be tested for proper operation every 30 days.* Whenever any report is made on the steam generator, a thorough check should be made. Safety devices should be tested, if required. The steam generator should be washed according to special instructions.

Wiring Connections—Wiring connections should be checked for tightness, loose terminals at sockets, and any indication of heating should be investigated. The connections should be spaced so that they cannot touch.

Relays—Relays should be checked for worn thin or burned contact tips; condition of blowout coils; wipe of contact tips; air gap; worn shunts; wear-in pins; the armature return spring should be in good condition; air-operated contactors should be checked for proper air pressure and all leaks should be corrected. Sluggish operation of contactors should be corrected.

Voltage Regulators—The voltage regulators must be given careful attention regarding loose connections, burned or dirty contacts, burned open resistances, voltage setting should be checked as frequently as possible to insure that the regulator is maintaining the proper voltage. Each time the regulator voltage is checked the exciter field current must also be checked. This is a very important item of maintenance and should not be neglected.

Lubrication

Lubrication—Electric Motors and Generators—Lubricate the armature roller bearings using an approved grade of special grease sparingly. Do not over-lubricate.

Road passenger locomotives: Follow instructions on Form 1226-DS.

Switch locomotives: Grease as follows:

Small motors	2 oz. of grease
Main generator	6 oz. of grease
Auxiliary generators	3 oz. of grease
Exciter generator	3 oz. of grease

Traction Motor Armature Bearings—Follow special folio instructions.

Air Compressor Motors Oil Lubricated—Check the oil level at least once a week; refill the oil well to restore the level to a maximum depth. If the oil leaks away too soon, check the bearings for excessive wear. Only an approved grade of oil (SAE 30 gas-engine oil).

Drain Oil-Diesel Engines—Change the crankcase oil in the Diesel engine crankcases as instructed. Used oil should be placed in clean drums and turned over to the stores department for shipment to Topeka, Kan., where the oil will be re-refined. Do not allow the fuel oil and dirt when the crankcase is washed to be drained into the lubricating oil. Show the date of the last oil change on the form. All oil must be removed from the tanks, the camshaft troughs and the engine crankcases.

Change Oil in Air Compressors Every Three Months—The oil in the crankcases of the air compressors should be changed every three months of service. Used oil should be sent in for re-refining to Topeka, Kan.

Main Contractors and Reverse Air Cylinders—Use a highly refined chemically-neutral, non-freezing oil. Not less frequently than each 90 days the cylinder heads should be removed and the interior of the cylinders given a light coat of special roller-bearing grease. If the packing leathers are hard they should be renewed.

Oil Level in Main Governor and Overspeed Governor on Diesel Engines—Check daily; if required, add approved oil.

Truck Journal Boxes—On switch engines check as frequently as possible adding oil of an approved grade if required. Check road engines as indicated on Form 1226-DS.

Truck Center Castings—Brake Rigging—Truck Pedestal Jaws—Lubricate with engine oil not less frequently than every 30 days on switch locomotives, and every trip on road locomotives.

Throttle-Control Linkage—Lubricate with special roller-bearing grease every 30 days for switch locomotives, and as indicated on the form for road locomotives.

Drain and Refill Crankcase of Steam Generator Feedwater Pump—Drain and apply fresh oil every 90 days. Use only an approved grade of oil.

Traction Motor Gears—Lubricate with an approved grease at least once a month for switch locomotives, and as indicated on the form for road locomotives.

Repack—Waste—Type Traction Motor Armature Bearings—These bearings should be repacked every 30 days. At the time of repacking the bearing, the oil well should be examined for flakes of bearing metal. Clearance of the bearing may be checked with a feeler gage. Oil in the well should be checked for water content using a syphon furnished. If water is present, all oil must be removed from the oil well. See the instruction book for details of packing bearing. Use only approved long strand wool waste for packing and an approved oil for lubrication.

Examine and Repack Traction Motor Axle Suspension Bearings—These bearings should be repacked every 90 days. Use only approved long strand wool waste for packing and an approved oil for lubrication.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Types of Crown-Sheet Patches

Q.—In applying a welded patch to the front of a crown sheet of a locomotive firebox should the patch be made saw-tooth or rectangular shape?—J. M. D.

A.—The shape of a crown-sheet patch is of little importance from a standpoint of strength, as the strength of the structure is not dependent upon the strength of the patch. The crown sheet is supported by the staybolts and the load on the patch is carried by the staybolts.

The shape of the patch should be as uniform as possible and large enough to replace the damaged portion of the sheet. It is not necessary that any uniform shape

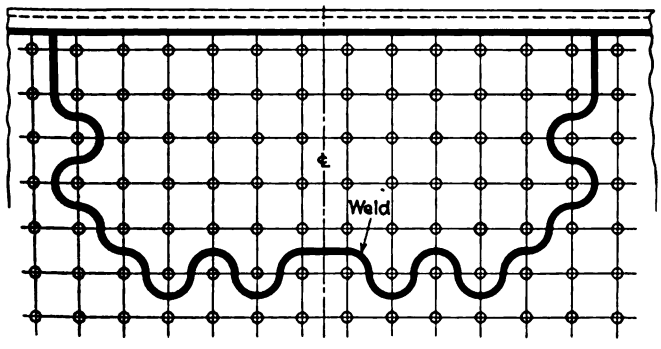


Fig. 1—Saw-tooth patch

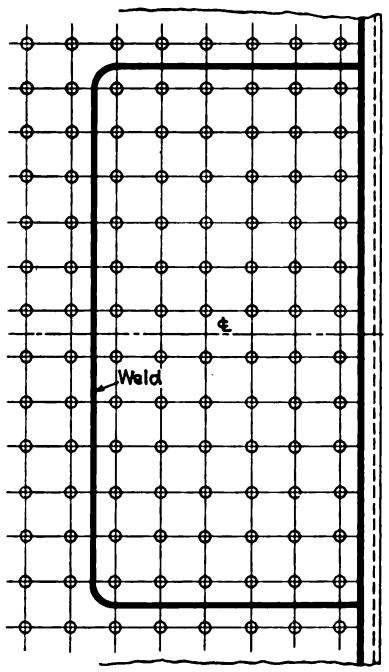


Fig. 2—Rectangular shaped patch

be adopted, the shape of the patch being governed by the area that is damaged and requires renewing. The joint between the patch and crown sheet should be spaced evenly between the two rows of staybolts.

Fig. 1 illustrates what would be considered a saw-tooth patch. Its advantages are that a maximum amount of welding is obtained for securing a given patch and by zig-zagging the weld, the weld is supported by three rows of staybolts instead of two. Its disadvantage is its irregular shape which causes greater difficulty in fitting and applying.

Figs. 2 and 3 illustrate a rectangular and diamond shaped patch, respectively. These types of patches are in common use, are simple to make and apply, and are for all practical purposes the most logical types of patches to be used in this location.

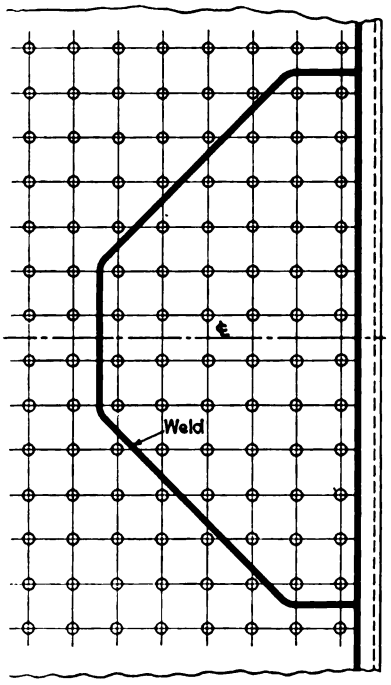


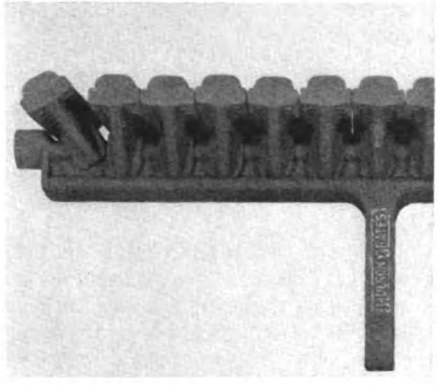
Fig. 3—Diamond-shaped patch

NEW CAR AND LOCOMOTIVE APPLIANCES AT THE EXHIBIT

Improved Hulson Grate Design

The Hulson 12-in. Tuyere-type grate is a new design in that the carrier bars are located on 12-in. centers instead of the previous standard 10-in. centers. The carrier bar has been changed and a locking arrangement has been developed which has eliminated the loss of units in service.

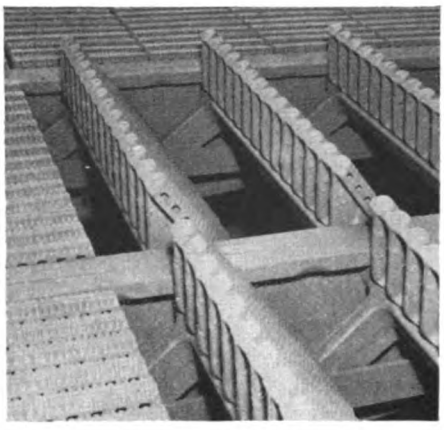
The unit for the 12-in. center grate measures 2¼ in. wide by 11¾ in. long and weighs 8¾ lb. It is available in any net air inlet from 12 to 26 per cent of the grate surface and is made of close-grained grey iron having a tensile strength of 30,000 to 45,000 lb. per sq. in. The sections through the unit are uniform for even heat transfer. Sixty-six to 78 per cent of the air inlet through the total grate area is in the tuyere opening. The "straight" draft air opening at the ends of the fingers is limited to ¼ in. Ash-pan loss when firing up and in service is negligible with numerous tests showing a loss of less than ¾ lb. of fine coal or dust per square foot of grates surface.



The last Hulson grate finger is "rolled" into place locking the units into position

The carrier bar is a stubby I-beam having trunnions 2¼ in. in diameter with a bearing surface 1¼ in. long. A ¾-in. steel pin is cast in the trunnion extending 2 in. into the base of the bar, eliminating breakage or failure of the trunnion. The top surface of the carrier bar is 2½ in. wide and the bearing surface is 1½ in. in width.

The units do not oscillate in service and, for this reason, the sides of the units are not subjected to excessive wear which would increase the air space after a long period of service. The units are applied only at one end of the carrier bar. The last unit is "rolled" into place as indicated in one of the accompanying illustrations. Two-thirds of its bottom face is engaged by the carrier rib and due to this generous bearing the unit can not be dislocated or lost under any operating condition.



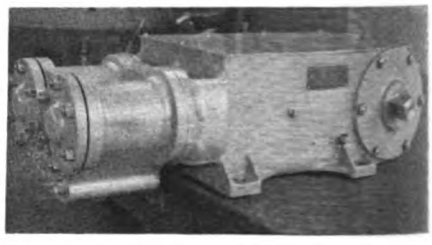
The Hulson 12-in. grate assembly has a 5¼-in. free opening in full open position

In full open position, the 12-in. grate has a 5½-in. free opening. This large free opening permits any section of the fire to be dumped quickly and eliminates the need of a drop grate. The grate shakes easily, yet the carrier-bar trunnions are placed sufficiently high on the units to lower the center of gravity so that a disconnected grate will remain level.

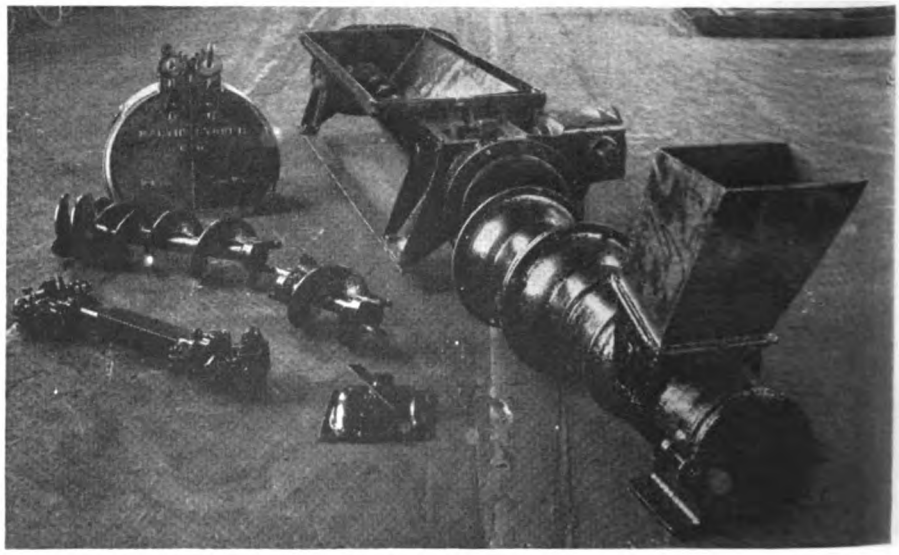
The weight of the 12-in. unit assembly averages from 68 to 78 lb. per sq. ft. depending upon the ratio of the length to the width of the firebox and the number of sections required in width. The three-section assembly has an area of 94.91 sq. ft. in a firebox 126¼ by 108¼ in. The two-section assembly has an area of 70.28 sq. ft. in a firebox 120⅞ in. by 84¼ in. These grates are manufactured by the Hulson Grate Company, Keokuk, Iowa.

Martin Locomotive Stoker

The features of the Martin stoker, manufactured and sold by the Locomotive Finished Materials Company, Atchison, Kan., are its all-steel construction, ease of application, the method of coal distribution by means of adjustable jets on the distributing plate and the hammer-mill type crusher box which controls lump size. The total weight of the stoker complete with a stoker engine is approximately 3,950 lb.



The Martin stoker engine



The Martin stoker is of all-steel construction

Only 1,685 lb. of this equipment is on the locomotive with the stoker engine installed on the locomotive frame. This permits the economical installation of the stoker engine on the locomotive instead of on the tender, thereby eliminating the need of reducing the water capacity in small tenders to furnish space for the stoker engine. It is not necessary to redesign or enlarge the fire-door opening in the boiler head to apply this stoker.

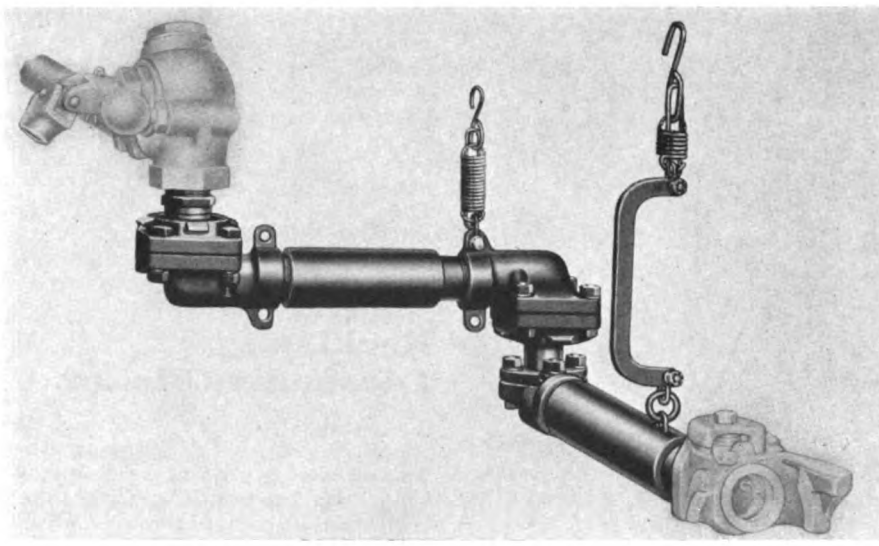
The conveyor trough is made of boiler plate welded to the gear box and to the crusher box. The gear cases, ball joints, conveyor screws, and the riser-conduit elbow are of cast steel. The conduit is made of steel pipe, while the riser conduit is of welded-plate construction. The stoker has large bronze bearings in the crusher box and heavy-duty roller bearings in the gear box. The gears are of heat-treated alloy steel.

The stoker has a coal crusher with extended prongs which breaks large lumps of coal into clusters instead of pulling these lumps against the plate and thus creating an excessive torque on the conveyor screw and the rear-end bearings. These clusters pass through a cowl between the conveyor screw flight and the conveyor screw in sizes approximately 4 in. by 6 in. which is too large for economical firing. Then, by the action of breaker hammers, the coal is reduced to the proper size for firing.

The riser conduit is rectangular in shape from its base to its discharge end, which permits the coal to be delivered evenly in a loosened mass onto the distributing plate. As the coal pyramids inside the fire-door hood on top of the distributing plate, the coal falls in front of the jet bolts, and is from there distributed over the fire-box area. As the jet bolts are adjustable, the accurate adjustment of the jets may be made for proper coal distribution.

Power Reverse Gear

The cross-sectional diagram shows the Leathem power-reverse gear which is being introduced by the Paxton-Mitchell Company, Omaha, Neb. The principle of this gear is embodied in an air-cushioned piston head with a reciprocating valve inside, this arrangement producing instant equalizing pressure on both sides of the piston head through a one-to-one ratio of piston travel to valve travel.



The Barco FT-2 steam-heat connection—the U-shaped bar in the safety support gives clearance for the air hose

Through this design, an immediate reaction takes place to any ordinary leakage and to forces applied through the valve gear, eliminating the possibility of creeping from these sources. There are only two pins to be maintained between the reverse lever and the operating valve. This reduces lost motion to a minimum and eliminates another cause for reverse gears creeping. With the equal ratio of piston travel to valve travel, the engineer has constant, sensitive control over the valve setting, resulting in efficient and economical locomotive operation.

Horizontal Steam-Heat Connection

The Barco FT-2 horizontal steam-heat connections manufactured by the Barco Manufacturing Co., Chicago, are used on streamlined cars where conditions do not permit the A. A. R. recommended location of end valves. They have all of the important features of the standard A. A. R. FT-1 and many of the parts are interchangeable.

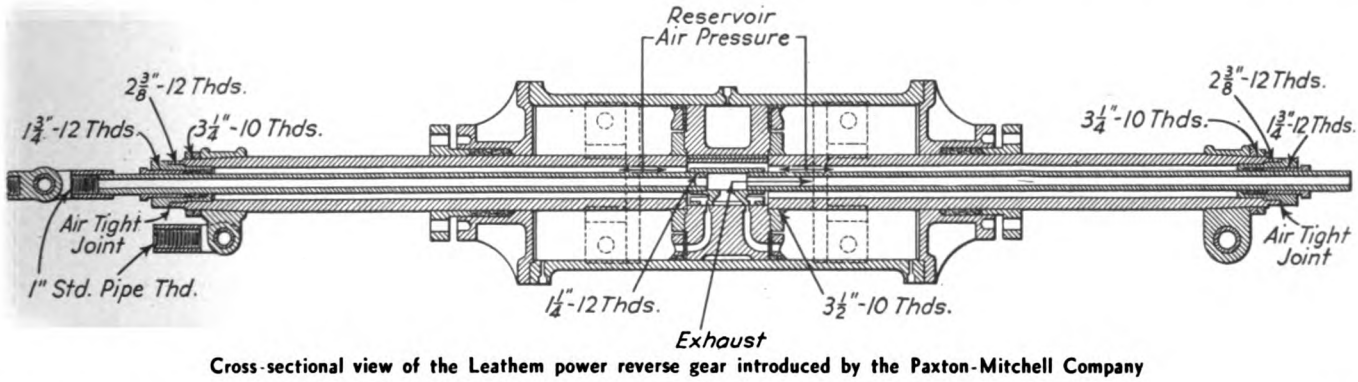
They have been improved by the application of hardened alloy-steel wearing parts instead of the bronze wearing parts formerly used, and 40 per cent additional flexibility has been obtained. These connections are made in 2 and 2½-in. sizes. In addition to the 2½-in. size being a new connection, the 2-in. size has been changed by the use of a U-shaped bar in the safety arrangement for holding up the connection. This was done in order that this safety appliance would not interfere with the rubber air hose.

Oil Divider for Lubricating System

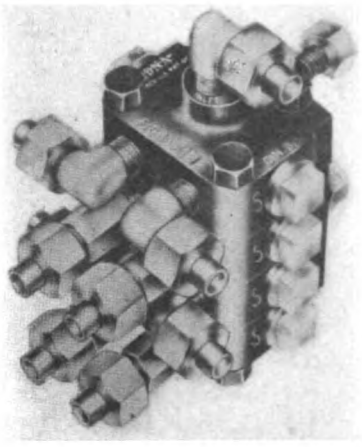
The Edna positive oil divider is a precision device of the hydraulic type with only three or four moving parts, depending upon the number of outlets. These dividers will operate from atmospheric pressure to 10,000 lb. per sq. in. without any harmful effects to the device and without impairing the accuracy of the discharge.

The outstanding feature of the divider is the hydraulic lock. To prevent the plungers from assuming positions on center, thereby rendering the divider inoperative, a principle, known as a hydraulic lock, is employed. This lock acts to hold the pistons alternately to the ends of their strokes before the next sequence in the oil cycle of the divider takes place.

The divider is furnished with from two to eight outlets with double as well as



Cross-sectional view of the Leathem power reverse gear introduced by the Paxton-Mitchell Company



The Edna eight-feed oil divider

single discharges in the same device. This permits twice the amount of oil to be delivered from one or more outlets as is delivered from the remaining outlets in the same divider. This result is accomplished ordinarily by the use of plungers having twice the area of the standard plunger.

As an example of what can be accomplished, the following arrangement is in service: One feed from an eight-feed mechanical lubricator on a roller-bearing equipped locomotive is connected to an Edna two-feed divider and outlets from this divider are connected to two eight-feed dividers. The discharges from these lubricate eight engine-truck pedestal faces and eight points on the front and main wedges. Six feeds from the same lubricator are connected to six eight-feed dividers, the oil from these being used to lubricate driving and trailer-truck pedestal faces as well as the wedges. The remaining one feed from the lubricator is connected to a six-feed divider, the discharges from which lubricate the guides and link blocks. There is, therefore, a total of 70 machinery points lubricated through the use of dividers and an eight-feed lubricator.

This device requires no repairs, inspection or maintenance and needs only a periodical cleaning. It is a product of the Edna Brass Manufacturing Co., Cincinnati, Ohio.

Berkley Locomotive Stoker

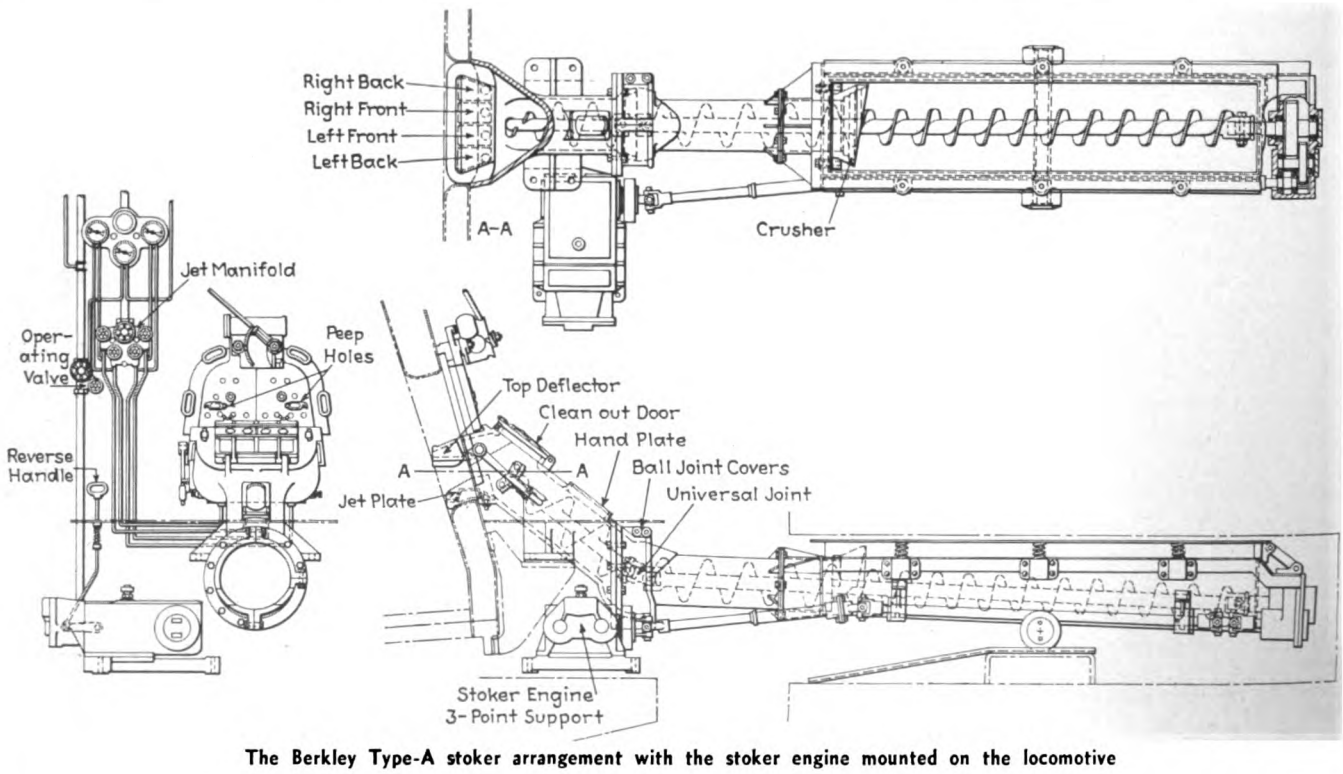
The Berkley locomotive stoker is a simple machine of proven engineering design with all moving parts mounted on sealed anti-friction bearings. Applications have been made on several railroads, including the Seaboard, which has had 30 in service for over two years.

The stoker comprises three principal parts—the stoker engine, riser, conduit, and tender-conveyor unit and weighs 4,017 lb. The stoker engine is designed for either saturated or superheated steam with all moving parts completely enclosed and oil sealed. The cylinders, piston valves, reverse valves and cylindrical crosshead guides are bushed with removable nickel cast-iron sleeves, and the crankshaft is mounted on ball bearings. The cylinders, valves and reverse valve receive valve oil from the mechanical or hydrostatic lubricator on the locomotive, and the remainder of the engine is lubricated by a splash system requiring six quarts of oil. The engine is reversed by a manually operated valve built integral with the engine and requiring no piping. The location of the engine is optional; it can be placed on the locomotive, tender, or at the rear of the gear box.

The riser conduit is connected with the ball of the tender unit beneath the cab deck and extends upward through the deck with its upper portion conforming to the contour of the fire-door opening. In the top portion of the conduit is a clean-out or inspection door which is convenient for removing clinkers from the firebox. If any foreign matter should get into the riser conduit, it can easily be removed through the clean-out door or hand-plate which is located at the lower portion of this unit.

The tender-conveyor unit is supported on two wheels mounted on roller bearings with the track secured to the tender. The unit consists of a trough, trough screw, crusher and gear box. The length of the conveyor trough may be varied to suit the length and capacity of the tender. The amount of coal delivered to the conveyor trough is controlled by side plates that are arranged in the tender deck. All bearings are of the roller or ball type, properly lubricated and oil sealed. The trough screw is continuous from the gear box to the ball joint of the riser conduit and is connected to the conduit screw by a universal link, two blocks, two bolts, and two pins. The thrust load of the riser conduit screw and the trough screw is taken by two double-row ball bearings in the gear box. All the gears are made of special heat-treated steel, mounted on ball bearings and oil sealed. The thread type crusher is located at the forward end of the conveyor trough, crushing the coal to the proper size and supplying it evenly and continuously to the riser conduit.

The top deflector does not extend into the fire box. Its use assures satisfactory distribution of coal to the back corners of the firebox and it also deflects fine coal to the fire bed which otherwise would be lost through the stack. The jet apron fits in the lower portion of the upper part of the riser conduit and is held in place by two



The Berkley Type-A stoker arrangement with the stoker engine mounted on the locomotive

tapered set screws on either side of the riser conduit. To remove the jet apron it is only necessary to slack off the two set screws and disconnect the four ½-inch pipe unions below the conduit. The number and size of holes used in the jet apron are variable to suit the size of firebox and the type of coal used. It is divided into four compartments, each of which is controlled by a separate valve located in the jet manifold.

A gage is located on each side of the steam-gage panel with the black hands of these gages indicating the back corners and side sheets and the red hands indicating the front of the firebox. These two gages give the fireman an accurate reading of the jet pressure which will vary from 10 to 45 lb. per sq. in., depending on the weight of the coal being distributed. On the same gage mounting is located a steam gage showing the stoker engine and boiler pressures.

The stoker is made by the Berkley Machine Works & Foundry Co., Inc., Norfolk, Va.

Locomotive Staybolt-Hole Bushing

The purpose of the Lewis Sealtite staybolt hole bushing is to furnish a simple and effective means of maintaining standard staybolt diameters. When repairing locomotive boilers, staybolts are frequently renewed and in this operation it is necessary to ream and re-tap the staybolt holes. The holes become enlarged beyond the maximum allowed diameter after they have been reamed and re-tapped several times. To correct this it is sometimes the practice to apply a patch or to weld up the staybolt holes. These bushings eliminate the need for patching or renewing the throat and wrapper sheets.

The bushings are made of double-refined staybolt iron manufactured to the customer's specifications. Two lugs on the inside of the bushing make it possible to apply and tighten the bushings with an air motor. After the bushings are applied, they are drilled and tapped to suit the

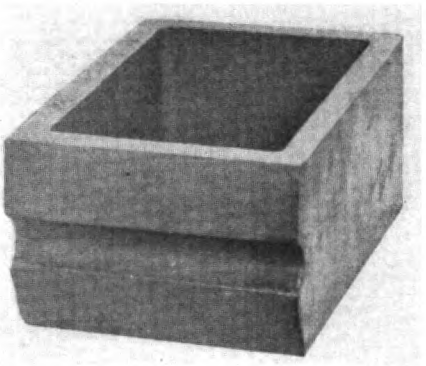


The Lewis Sealtite staybolt-hole bushing

staybolts. The bushing is a product of the Lewis Bolt & Nut Company, Minneapolis, Minn.

Locomotive Spring Band

Stanfast spring bands have solid corners, are free from burning, are of uniform



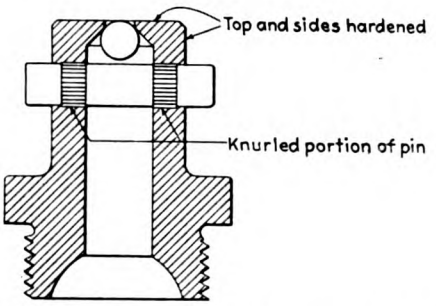
The Stanfast spring band

thickness, and require no welding. They have a tensile strength of 70,000 lb. per sq. in. and an elastic limit of 36,000 lb. per sq. in.

There is no difference in the application between the home-made forged or welded iron band and the Stanfast band, which is made to the same size and tolerance as the home-made band. It is the Stanfast band's "resistance to stretch" which causes it to give an economical performance on over 40 railroads that have used it. This spring band is a product of the Standard Brake Shoe & Foundry Co., Pine Bluff, Ark.

Improved Spee-D Filler Neck

An improved filler neck for application to connecting rods lubricated by the Spee-D method has been developed by the Reliance

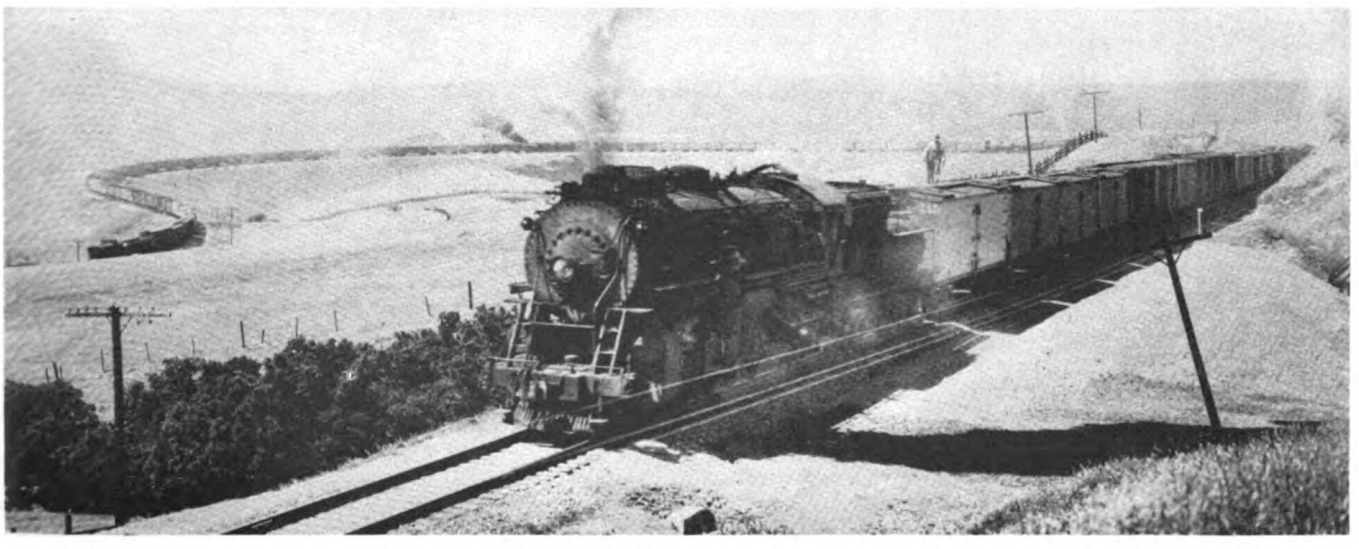


The Spee-D filler neck with knurled pin and hardened wearing surfaces

Machine & Stamping Works, New Orleans, La. To avoid loss of the pin in this fitting, a hardened knurled pin is now forced into position in the fitting under high pressure. This operation embeds the knurled portion of the pin into the surrounding metal and holds the pin securely in the fitting. The application of the knurled pin has been adopted as standard on all of these filler necks.

Another improvement, also adopted as standard, is the hardening of the wearing surfaces of the filler neck. Both of these improvements are indicated on the accompanying cross-sectional diagram.

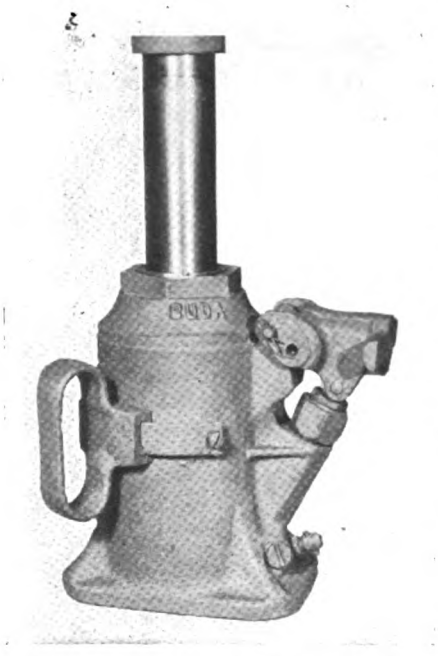
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NEW SHOP TOOLS AND EQUIPMENT

Hydraulic Two-Speed Journal Jack

The Buda Company, Harvey, Ill., announces the manufacture of a new model 25H10 hydraulic two-speed journal jack. As shown in the illustration, this is a compact hydraulic jack for work where raising and lowering operations must be under complete control at all times. It is designed to be dependable and adaptable for working in limited spaces and has a number of characteristics which make it especially useful for removing railroad car journal bearings. For this sort of work,



Buda Model 25H10 hydraulic two-speed car journal jack in raised position

the jack is said to be unusually fast, doing the job in about one-half the time required with other types of jacks.

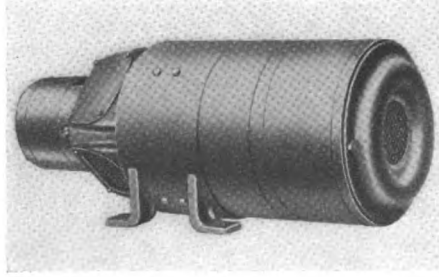
This jack has a capacity of 25 tons but is designed to carry 55 per cent overload safely. It has a rise of 6 in., an overall height in the down position of 10 in., and weighs 45 lb. The principal advantages claimed for this jack include: Hydraulic operation, assuring complete control of the load at all times; two speeds, fast speed for medium and light loads and second speed for heavy loads; positive stop and a limited rise, with no chance for the ram to bind in the cylinder at the top position; rugged construction with a ram made of solid bar stock and base of high-strength malleable iron; safety and ease of operation with a swivel handle to assure ease in carrying; practically no maintenance, as there are only two places for adjustments or cleaning out; use of a solid casting without blind plugs to present a possibility of oil leaks.

Speed-Variator Equipment

Complete speed-variator equipment operating from an alternate-current source of supply and furnishing wide ranges of adjustable speed by means of the well-known generator-voltage-control scheme has been announced recently by the General Electric Company, Schenectady, N. Y. Each equipment consists of an adjustable-speed, direct-current motor, an adjustable-voltage motor-generator set with control, and a separately mounted generator-field rheostat. Standard speed ranges are available up to 16:1 ratio.

The motor can be mounted directly on the driven machine, with the speed-changing control mounted nearby. The units are designed to operate from 3-phase, 60-cycle, 220-, 440- and 550-volt alternating-current power. The generator-field rheostat of the potentiometer type provides speed changes in small increments over wide ranges.

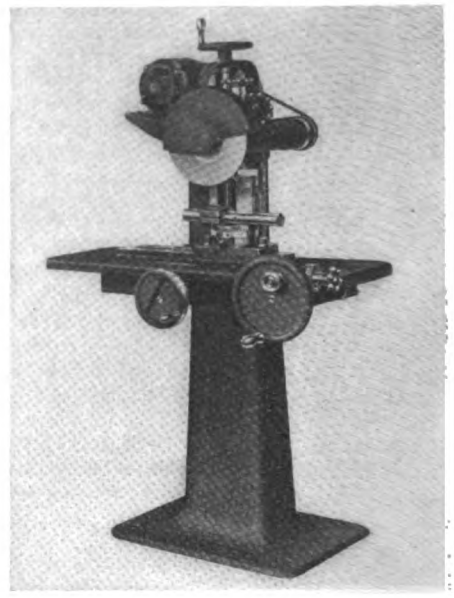
The speed variator is suitable for many industrial applications where adjustable speed has a direct bearing on the control of quality and efficient output of the driven machine. This flexible power medium is applicable to material-handling operations throughout the whole industrial field. Machine tools, pumps, fans and printing machines are natural applications. Heavy starting duty and slow threading speed, quick stopping and fast acceleration, coupled with flexible control, are some of the major features of this equipment.



General Electric motor-generator set for use as part of speed-variator equipment

Single-Purpose Chaser Grinder

While the Geometric Tool Company, New Haven, Conn., builds several types of grinding fixtures which may be mounted on most universal surface grinders, there has been a demand for a single-purpose chaser grinding machine. The No. 20 chaser grinder has just been developed with one purpose in view, the accurate re-sharpening of chasers. This machine has a longitudinal travel of 8 in. with a working surface 4 in. by 19 in. It occupies a floor space of 44 in. by 32 in. and is



The No. 20 Geometric chaser grinder is designed to accurately resharpen die-head and tap chasers

equipped with a one-third horsepower motor with a V-belt drive.

The work table is mounted directly on a plane, ground surface and may be fed manually both longitudinally and transversely. The spindle housing is mounted pivotally on a saddle equipped with three ground ways. The saddle may be adjusted vertically by means of an elevating hand wheel. After adjustment, the saddle can be securely locked in position against the ways. Final vertical adjustment of the grinding wheel is made by means of a small micrometer hand wheel.

The weight of the driving motor in combination with the pivotal spindle mount prevents any back lash from developing in the micrometer spindle adjustment. The

spindle itself is equipped with a tapered bronze bearing at the front and a radial ball bearing at the rear. Adjustment for wear can be made easily by tightening an adjusting nut at the forward end of the spindle. If desired, the machine can be equipped with an exhaust hood.

Welder Designed for Multiple Operation

The P & H Hansen square-frame welder is a machine that measures less than 33 in. in length and one foot in height but delivers uniform welding currents, ranging from 200 down to 15 amperes. The current selection is simplified by a single control on the welder. Once the current setting has been made, the generator automatically responds with the desired arc length under all welding conditions. Missynchronization of open circuit and arc voltage is impossible because of the automatic volt-ampere regulation, self-excitation, and internal stabilization of this machine.

The square-frame design permits a better arrangement of the welder's component parts, gives it an over-all compactness and allows for the convenient stacking of the units for multiple operation. A paralleling arrangement by which the capacities of two or more of these welders may be combined has been developed specially for this welder. With this parallel hook-up an operator has at his disposal for peak loads the aggregate current of two or more machines. When the connection is cut, each machine can be used separately by individual operators.

The single current-control feature is retained for the combined units. The selector of each machine is connected to that of the next machine in series by means of a multiple shifter which, when set for a given current, automatically sets the connecting machines at that amperage. Thus, for a current of 375 amperes using three machines, the multiple shifter is set at 125 amperes which sets all the machines for that output and producing a combined resultant current of 375 amperes. When the welders are operated as individual units, a swing nut on the connecting rod of the multiple shifter is loosened and the rod is disconnected, enabling separate settings to be made on each machine.

Single or multiple units are available for stationary or portable mountings. This welder is manufactured by the Harnischfeger Corporation, Milwaukee, Wis.

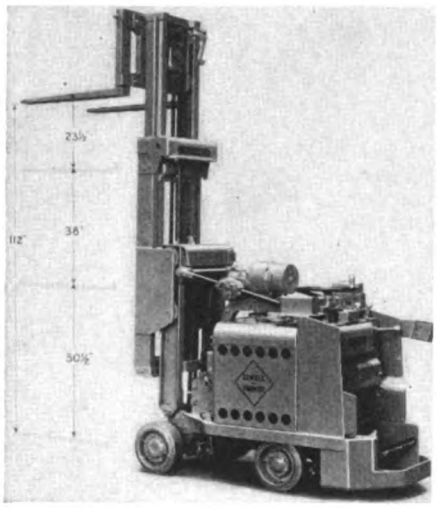


The capacities of two or more P&H-Hansen WD-150 welders may be combined by a simple paralleling arrangement—Two of these machines are shown above ready for parallel operation

Triple-Lift Fork Truck

The Elwell-Parker Electric Co., Cleveland, Ohio, has brought out a fork truck, ERS-3T, capable of elevating loads on skids or pallets to three levels instead of one.

The elevating mechanism is built in three telescoping sections. When the uprights are completely lowered, the forks just clear the floor. Under the operator's control, the forks can be raised to 50½ in. on the first lift, 88½ in. on the second, and 112 in. on the third. The rate of upward travel is 20 ft. per min. with a 1,500-pound load. With the telescoping members lowered, the over-all height of the truck is but 74 in. Thus, the loaded truck can pass through doorways or beneath low overhanging pipes or conveyor systems.



The Elwell-Parker triple-lift fork truck is capable of elevating loads to any one of the three levels indicated

The truck has an Elwell-Parker 4-pole, main driving motor, series-wound, and capable of sustaining a 500 per cent overload. It is direct connected to a free-coasting worm and gear and drives the two wheels nearest the load, assuring ample traction. The power source can be furnished by either acid or alkaline storage batteries. No fuses are needed to protect the motor. When lowering the load, regenerated power is returned to the battery.

The hoist is operated by a separate motor controlled by a push-button. It may be tilted 15 deg. backward or 5 deg. forward from vertical. The two hoist chains have a safety factor of nine and either will handle the load. Vertical uprights and tilt gearing are designed to prevent sidesway.

The hoist has a ratchet device that operates when the descending load meets with an obstruction. A slip clutch serves the same purpose when ascending loads are obstructed. A solenoid brake locks the hoist load in any position. The form arms of the truck are supplied in a variety of dimensions to suit application.

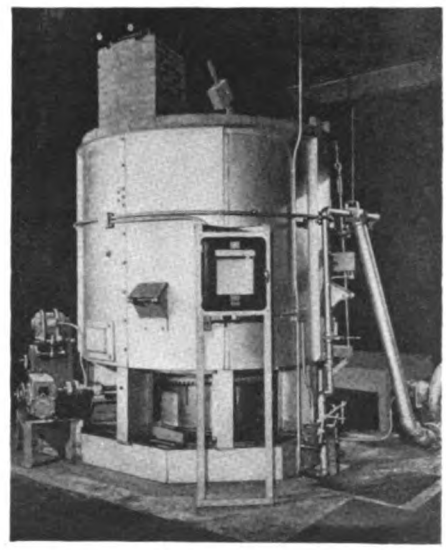
The two wheels farthest from the load are steered by a handwheel. Drive wheels are 15 in. in diameter and 5 in. wide, the trail wheels are the same diameter, 3½ in. wide.

Heat-Treating and Forging Furnace

A center-fired rotary furnace for forging and heat treating work has been developed and patented by the Mahr Manufacturing Co., Minneapolis, Minn. Its primary feature is its single-burner center-firing principle. This burner, located at the bottom of the hearth, fires up through a long combustion cone of special design. This cone insures that the products of combustion come into equilibrium with themselves before coming into contact with the steel, thereby minimizing scale formation and decarburization.

A furnace free from cold spots, even at the furnace door where a cold spot usually exists, is obtained by employing the center-firing principle. The single burner feature assures uniform control over the furnace atmosphere. Positive pressure within the furnace is maintained by an automatic Vent-O-Matic stack damper.

The rotary table is gear driven from a variable-speed transmission. The furnace is equipped with an improved type of sand seal having filling chambers for maintaining the depth of the seal. A special door, equipped with an air curtain, protects the operator from the heat. Automatic temperature controls, as well as an individual low-pressure blower for making it a self contained unit, can be installed. These



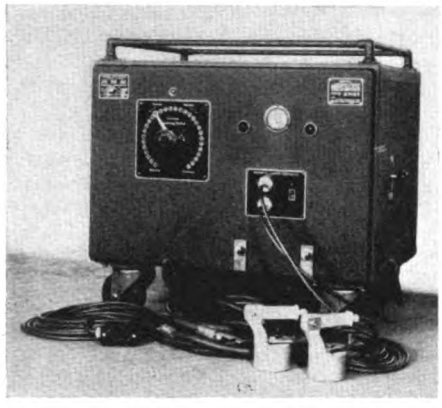
The Mahr center-fired rotary furnace

furnaces are manufactured in hearth diameters from 4 ft. to 9 ft., operating on either gas or oil and producing temperatures from 1,400 to 2,500 deg. F.

Portable Inspection Equipment

The illustration shows newly redesigned portable Magnaflux equipment constructed especially for the railroad field, and widely used in the inspection of railroad parts. It is operated by alternating current capable of delivering a maximum of 3,000 amp. at low voltage, and is equipped with two magnetic leech contacts for use in the inspection of welds, forgings, boiler shells, etc., by the direct-contact method.

A 30-point dial switch is available for control of the magnetizing current and for demagnetizing purposes. This switch is now constructed for the semi-automatic demagnetizing of parts. The frame is of heavy welded angle-iron construction with perforated, removable, side and back panels, and with a rail around the solid-steel top for the convenient storage of cables and accessories. The cabinet is mounted on heavy ball-bearing casters with wide tread wheels. The total weight of the unit is approximately 600 lb. The unit is made by the Magnaflux Corporation, Chicago.



Portable Magnaflux equipment for railroad service

Tractor Crane with Pneumatic Tires

The Krane Kar, an industrial tractor crane, is now available with heavy-duty dual pneumatic tires for the traction wheels and single pneumatic tires for the steering wheels. Solid cushion rubber tires have been standard equipment in the past and for most uses they have been satisfactory. However, there are service conditions that make pneumatic tires desirable, particularly those in which this tractor crane encounters adverse road surfaces. These tires will furnish better traction and improve the riding qualities over soft roads, cobblestone roads and railroad tracks.



Krane Kar equipped with pneumatic tires

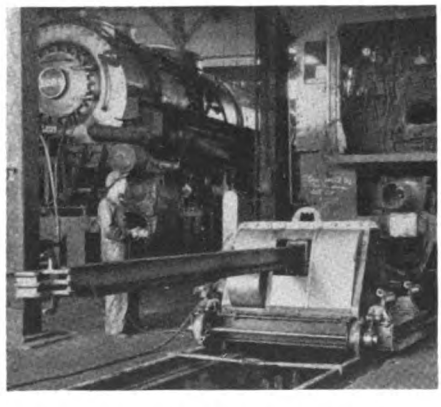
The pneumatic tires will be equipped with standard heavy-duty inner tubes, although puncture-proof inner tubes are obtainable as extra equipment. An auxiliary power air pump will be installed as part of the tractor crane's equipment for those who do not have conventional garage facilities.

On work in which the tractor crane is operated a substantial portion of the time in reverse gear, a directional transmission is available that produces four speeds in forward and four in reverse gear in place of the standard transmission with four speeds forward and one reverse. Allied equipment, such as electric magnets and clam-shell buckets, and telescopic booms as well as booms of greater length are also available.

The Krane Kar is obtainable in three sizes, Model A has a lifting and transporting capacity of 5,000 lb., Model AX 10,000 lb., and Model AY 20,000 lb. It is made by the Silent Hoist Winch & Crane Company, Brooklyn, N. Y.

Spotter Connects Tender to Locomotive

The Model E spotter made by the Whiting Corporation, Harvey, Ill., has a capacity of 45,000 lb., push or pull, which is 50 per cent greater than the power possessed by the older machines. This increase in capacity was furnished in order that the spotter could be used to connect tenders to locomotives after draw-bar examinations.



The Whiting Model E spotter has sufficient capacity to connect the tender to the locomotive

In addition, it serves for any locomotive spotting operation and to reduce valve setting costs.

The machine has a beam of sufficient length to produce a complete revolution of the largest pair of driving wheels used on our American railroads. One end of the beam is equipped with a coupling eye and the other end with a coupler. The spotter, roller-bearing equipped, is pushed to a designated position by hand, locked into place. After being coupled it can move the heaviest locomotives through push-button control. It can also spot these locomotives "on a dime."

Self-Contained Portable Arc Welder

The all-purpose a.c. FlexArc welder, designed for general utility service and production welding of every type, has just been announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The standard models of this welder are self-contained and operate on either 220 or 440 volts.



Westinghouse a.c. Flex-Arc welder

Current adjustment is easy, as it is only necessary to select the current desired and insert the bayonet plugs in the proper receptacles on the side of the welder. From 20 to 250 amperes of welding current is available in 27 steps with the increments properly proportioned to meet the needs of welding with a wide variety of electrode types and diameters. The current values are indicated in large numerals on the case.

A built-in De-Ion breaker insures protection against long sustained overloads such as might occur by accidentally leaving the machine short circuited. This breaker is also convenient for disconnecting the machine from the line without having to go back to a service or feeder switch. The open circuit or striking voltage is exceptionally low, being on the order of 80 volts at 20 amperes and ranging down to 50 volts at the highest current rating.

The welder is self-contained and portable, being enclosed in a steel case and mounted on three wheels. High efficiency,

high power factor and low no-load losses insure maximum operating economies.

Miller Features Maneuverability

Large bed-type milling machines, known as horizontal Hydro-Tel, have recently been announced by the Cincinnati Milling Machine Co., Cincinnati, Ohio. They are different from conventional heavy-duty bed-type millers, inasmuch as they have a high degree of maneuverability, even greater than the majority of knee-and-column-type milling machines.

The hydraulic table traverse and the spindle carrier traverse, actuated by Servo control mechanisms, are the reason for the extreme ease of operation. An effort of about one pound on the table traverse hand-wheel controls the hand feed of the table, a Meehanite iron casting which weighs approximately 4,000 to 6,500 pounds, depending on the size of the machine. Even though the table is loaded with an equal weight of fixtures and work, it requires no more effort to move it by hand. Likewise, the vertical movement of the spindle carrier by hand requires about a one-pound force on the handwheel.

All controls are closely grouped in a central and convenient location on the spindle carrier and at the rear of the bed, the position of greatest visibility for the operator to stand while working. With very little effort, the operator has complete accessibility and control of all setting up and operating levers.

Important features include independent and non-related feeds for the table and vertical movement of the spindle carrier. Each unit has feed rates of 1 in. to 25 in. per min., infinitely variable, and rapid traverse rates of 120 in. per min. The hydraulic circuit firmly positions the spindle carrier while the table feed is engaged and vice versa. There are 16 spindle feeds on a large dial at the side of the spindle carrier. The entire machine is automatically lubricated with filtered oil. The front bed provides a full-length support for the table, except for a slight overhang at the extreme end of the travel.

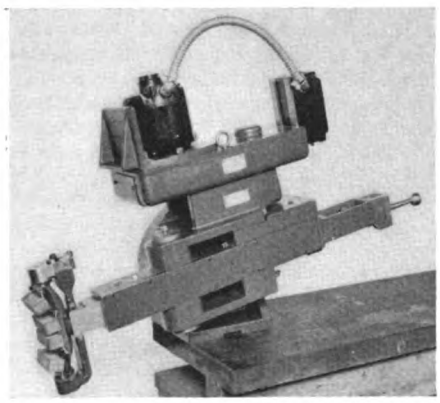
While this machine tool is primarily a general purpose miller, it is also well adapted for the milling of large dies, as shown in the illustration.



The Cincinnati horizontal Hydro-Tel milling machine is shown milling large dies

Superfinishing Heads For Engine Lathes

The new Foster Superfinishing heads are made in four sizes that are adaptable for almost any diameter of cylindrical work. The larger size of the inclined pivot-arm type, illustrated, has been used to Superfinish locomotive piston rods and car axle journals.



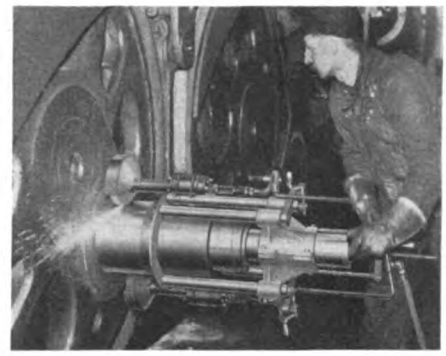
The Foster inclined pivot-arm type of superfinishing head may be attached to engine lathes

A common method of refinishing axle journals is by rolling them after they have been turned. The resulting finish, however, is wavy and characterized by high spots. By performing an extremely short Superfinishing operation, these high spots may be removed and a surface more geometrical in shape produced, making possible the more even distribution of the oil film. Therefore, the possibility of oil-film fractures and metal-to-metal contact is reduced and many hot boxes may be eliminated. While the actual micro-inch reading of the finished piece depends upon the previous machining operations, surfaces of two to four micro-inches (one micro-inch equals one-millionth of an inch) are easily obtainable.

These heads may be attached to engine lathes or any special lathes. The oscillating movement of the stones is sideways and is transmitted through a pivoted mounting of the arm. Stone retraction is obtained by a lever at the end of the arm. The stone pressure is spring regulated and stone holders may be changed quickly for different jobs. These heads are a product of the Foster Machine Company, Elkhart, Ind.

Portable Locomotive Crank-Pin Grinder

The Milwaukee crank-pin grinder will grind all types and sizes of crank pins without removing the wheels or guides from the locomotive. If a crank pin is worn out of quarter and stroke, this unit will remove high spots and correct these conditions if the pin was originally in the correct quarter and stroke. Worn or cut trailer- and car-truck journals, holes in the back end of main rods and similar jobs may also be reconditioned by this grinder. It is available with either an air- or electric-motor drive.

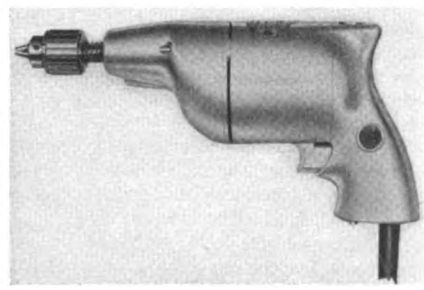


The portable Milwaukee crank-pin grinder in operation

The equipment is furnished with two grinding wheels operated independently by two motors. The depth of feed is controlled separately by a hand crank. A polishing wheel is used to finish the crank pin to any desired smoothness. The grinder is applied to the crank pin by the use of centering adapters which may be made up by the railroad to suit their own requirements. This equipment is made by the Goetz-Voss Corporation, Milwaukee, Wis., and the sales representative is the U. S. Metallic Packing Co., Philadelphia, Pa.

High-Speed Electric Tapper

The Tapgun was designed to meet the demand for a light-weight unit to handle portable tapping operation in small sizes on assembly jobs. It is equipped with a universal motor operating on either a.c. or d.c. current. A feature of this tool is



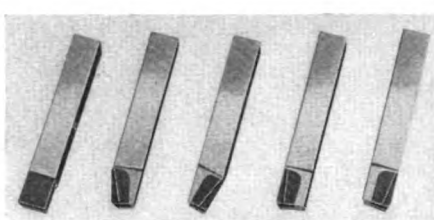
The Black & Decker No. 8 Tapgun

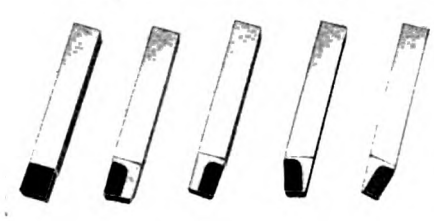
the automatic reversing mechanism which engages an idler gear when the operator pulls backward on the unit and automatically backs the tap out of the threaded hole at high speed. No reversing switch is needed.

The Tapgun weighs 3¾ lb. and measures 9¼ in. in over-all length. It taps up to 5/16 in. in cast iron, 3/16 in. in steel, and 3/8 in. in brass or aluminum. It taps at 400 r.p.m. and backs out at 525 r.p.m. This equipment is made by Black & Decker Mfg. Co., Towson, Md.

Carboloy Cutting Tools Standardized

The manufacture on a mass-production basis of a new line of cemented-carbide-tipped cutting tools introduced by Carboloy Company, Inc., Detroit, Mich., is intended to make it economically possible to decrease the amount of brazing and grinding now done by organizations who now purchase Carboloy tips to produce their own tools. This line covers in five standard styles and three grades the majority of all turning, boring, and facing applications. In addition, the new standard tools are also capable of simple conversion by the purchaser into hundreds of forms of special tools.

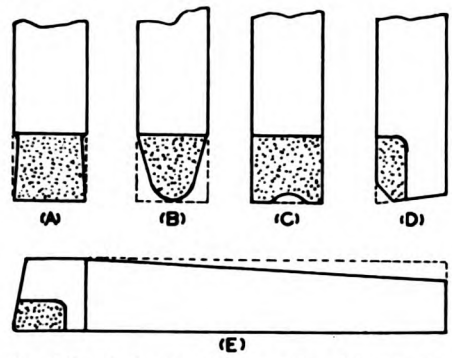




Carboloy standard tool line—Above: Steel-cutting tools with copper-colored shanks—Below: Aluminum color distinguishes tools for machining cast iron

One of the illustrations shows two complete sets of tools, one for cast iron and one for steel, in one of the seven sizes in which these standard tools are available. Differentiation between tools designed for steel cutting and those intended for the machining of cast iron is furnished by the color of the tool shank. Those for steel are copper colored and those for cast iron are finished in aluminum color.

The introduction of a standard line of these tools for the machining of steel has been facilitated through the development of a general-purpose grade for steel cutting. Tools made of this grade, 78B, will stand more abuse than those of the 78 grade, while they also have greater resistance to abrasion than the 78A grade. They are designed to take cuts up to ½ in. deep and feeds up to .030 in. For the machining of cast iron the standard tools are available in two optional grades.



Special tool forms may be produced by simple grinding operations on Carboloy standard tools

In the accompanying diagram are shown typical examples of special tools which may be produced from the standard tools through simple grinding operation. The dotted lines indicate the original shapes of the tools. Tools *A* and *B* are grooving tools, the first for square grooves, and the other for form grooves such as are used in pulleys. Tool *C* is another type of forming tool. All three of these are derived from style No. 1. Tool *D* shows how a style No. 7 tool can be converted quickly into a chamfering tool, while at *E* a facing tool has been produced from tool style No. 4 by grinding back the shank. Engineering studies at Carboloy indicate that well over 200 forms of tools formerly purchased as special may be produced from style No. 4 alone.

Direct-Current Arc Welder

The General Electric Company, Schenectady, N. Y., has announced a new 200-amp., d.c. arc welder which will produce any welding current from 25 to 250 amp. This wide range allows all-day manual welding to be done with currents up to 200 amp., using electrodes from 1/16 to 5/16 in. in diameter. Its capacity is sufficient for the use of electrodes as large as ¼ in. on occasional short jobs.



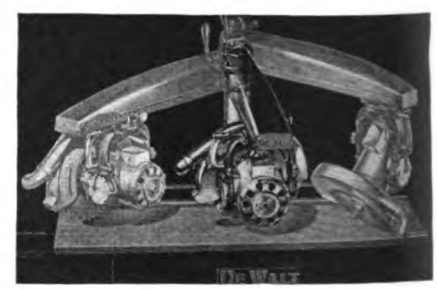
General Electric single-operator d.c. arc welder

The arc welder has two outstanding features. First, it provides for instant recovery of the voltage to an extent greater than the arc voltage after each short circuit, thus preventing time-wasting arc pop-outs. Second, it never allows current peaks to exceed three times the steady short-circuit current on any adjustment, thus preventing excessive heat and spatter and resulting in a saving of electrodes. Both of these features are made possible by a split-pole cross-field design.

Other advantages include excellent commutation, isothermic overload protection for the motor, self excitation, which does away with the necessity for an extra generating unit; quick adjustment of welding current, and horizontal mounting. Self-sealed ball bearings are used. An improved, highly efficient ventilating system prevents overheating even when the welder is operated within the proper range for long periods. A full range of current adjustment is obtained without the use of a current resistor. This results in a saving of 10 to 15 per cent of the power costs.

Versatile Wood-Working Machine

The DeWalt Type GE woodworking machine is capable of a variety of operations limited only by the ingenuity of the operator. It will cross cut, miter, rip, bevel cross cut, compound miter and bevel rip, using a combination saw blade. With the addition of dado heads, shaping cutters and other tools it will perform numerous other operations.



The DeWalt Type GE woodworking machine—The phantom views show some of the positions in which the arm and motor unit may be placed

This unit consists of a working table on which is mounted a column that can be elevated or lowered. The column supports a uniform cantilever arm which can be swung 360 deg. around the column. Riding on machine tracks, inside the arm, on sealed self-aligning ball bearings, is a carriage which suspends a yoke capable of being revolved 360 deg. horizontally. This yoke supports the motor or power unit to which all cutting tools are directly attached and this unit may be revolved 360 deg. vertically. The machine can be powered with motors from ½ to 25 hp. This selection of motors makes it possible for the machine to cut material from 1 in. to

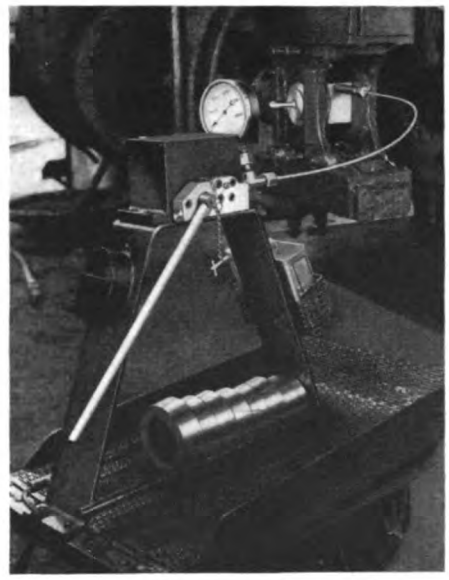
16 in. in thickness and cross cut material up to 33 in. in width.

The 1941 models feature an improved design in construction. They have cast nickel-molybdenum semi-steel machine frames, new shielded ball-bearing roller carriages, and tapered keys with mechanical adjustment which enable the operator to maintain the accuracy of the machine throughout its entire life. Another improvement has been made in the motor which is totally enclosed, fan cooled, of the 40 deg. continuous duty type. This motor features grease-sealed bearings which make lubrication unnecessary and is insulated with Fiberglas. This machine is manufactured by the DeWalt Products Corporation, Lancaster, Pa.

Hydraulic Piston-Rod Parter

The Sperry piston-rod parter is essentially a high-capacity hydraulic jack specially designed to fit into locomotive crossheads for the purpose of pressing out piston rods. The fit between crosshead and piston rod is quickly and easily broken without damage to these two important elements of the locomotive machinery. It is designed for portable mounting and convenient one-man operation. All component parts are made of a special steel alloy, heat treated to withstand extreme hydraulic pressure.

Two hydraulic jacks are available for use with this device. One is designed for use in crossheads with a width of four to five inches between the cheeks. This jack actually measures $3\frac{15}{16}$ in. in width, produces a maximum total parting force of 150 tons and weighs 33 lb. The other jack fits crossheads with 5 in. or more between the cheeks. It measures $4\frac{15}{16}$ in. in width, develops a total parting force of 250 tons, and weighs 51 lb. The pump used to operate either of the two jacks is capable of delivering 35,000 lb. per sq. in. and weighs 65 lb.

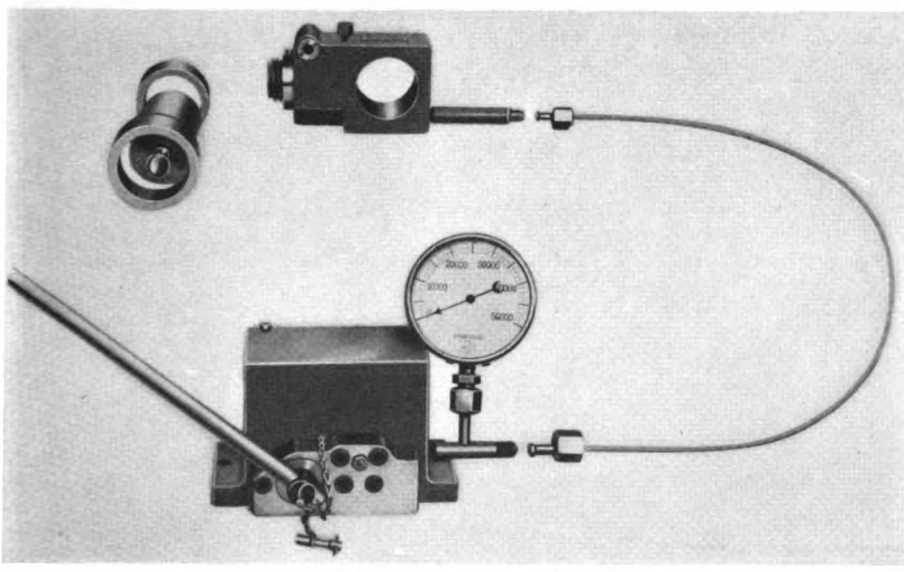


The piston rod parter in operation—The portable mounting facilitates handling

In operation, adapter bushings are first installed in the crosshead wrist-pin holes. These bushings are made up according to crosshead drawings and tapered to fit the holes. The correct size of jack is then placed in the crosshead and held firmly in position by the dummy wrist pin which passes through the jack and is supported on each end within an adapter bushing. The hydraulic force required to press out the piston rods is supplied by the pump which is connected to the jack by a heavy-wall steel connection tube. Only a few strokes on the pump handle are required to break the tightest piston-rod fit. This force has its reaction taken up over that section of the crosshead designed to take the connecting-rod thrust. There is no impact. The stress is slowly and evenly distributed on both sides of the crosshead, eliminating any possible distortion of the wrist-pin holes. The hardened-steel ram insert is aligned flush against the end of the piston rod protecting the lathe center hole against possible damage.

After a piston rod has been pressed out, the jack is removed from the crosshead and the ram returned to its cylinder by means of a wrench inserted in the end of a retracting pinion. The oil, thus being forced out of the cylinder, is returned to the reservoir through a by-pass valve which has been opened for this purpose. When the by-pass valve is again closed, the piston rod parter is ready for another operation.

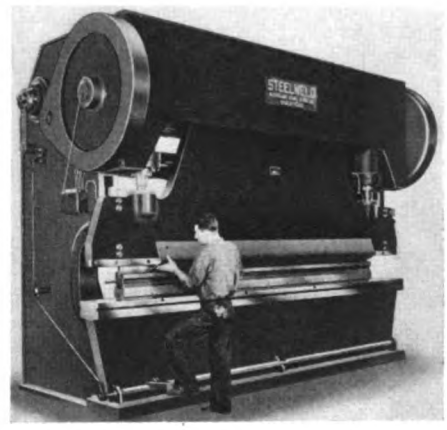
The portable arrangement, shown in one of the illustrations, has been found to facilitate the efficient handling of the piston-rod parter in moving it from one location to another. This device is made by Sperry Products, Inc., Hoboken, N. J.



The Sperry piston-rod parter showing dummy wrist pin with adapter bushings and the hydraulic jack with connections to the operating pump

Bending Press with All-Welded Frame

The Model J-12 Steelweld bending press, illustrated, is one of a line of presses with one-piece all-welded frames made by the Cleveland Crane & Engineering Co., Wickliffe, Ohio. This press will handle up to $\frac{5}{16}$-in. by 12-ft. plate between the housings and plate 14 ft. long over the total length of the bed and ram. Longer plate can be handled by extending the bed and ram either on one or both ends. The J-12 has a double end extension and a one-piece all-welded frame that will remain rigid for the life of the machine.



The Model J-12 Steelweld bending press

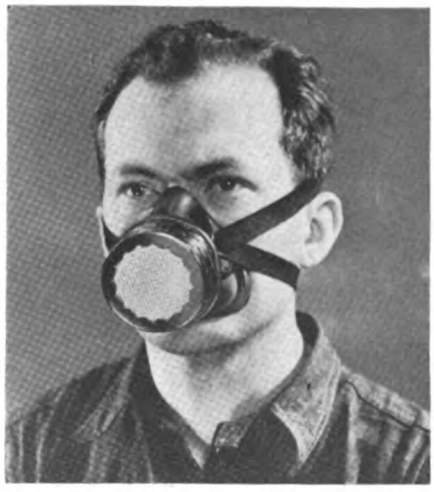
The ram is operated by two eccentrics, one on each side of the machine. Each eccentric is supported by three extra large main bearings and an eccentric bearing. The bearings are lubricated automatically by two oiling units mounted at each end of the press. All gears are protected with metal covers and the shafts are located at the rear of the machine away from possible damage by crane hooks or bent-up plates.

The press may be used for bending, forming, blanking, drawing, rubber-forming and multiple-punching operations. Several operations may be performed by passing the work successively through various dies set in position along the length of the

machine. Its approximate over-all dimensions are: 15 ft. 6 in. long, 7 ft. 4 in. deep, and 11 ft. high. It has the usual 18-in. throat which is standard for all Steelwelds.

Respirator Filter Cartridge

The American Optical Co., Southbridge, Mass., announces another new filter cartridge for its R-1000 respirator, thereby providing five interchangeable types of protection in one basic respirator. The new filter gives comfortable protection against toxic dusts formed by crushing, grinding or abrading such solids as lead, cadmium, arsenic, chromium, manganese, selenium, vanadium and their compounds.



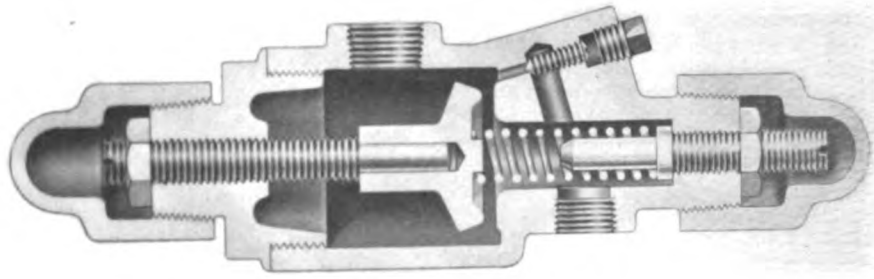
A filter cartridge for toxic dusts has been developed by the American Optical Company for its R-1000 respirator

The other four filter cartridges previously developed by this company give protection against: (1) Pneumoconiosis-producing dusts like quartz, asbestos, ores, coal, flour, etc.; (2) low concentrations of fumes, vapors or gases encountered in paint spraying, and other light organic vapors; (3) low concentrations of acid fumes and gases; (4) low concentrations of combined acid-organic gases and vapors.

Automatic Shut-Off Valve

If a flexible hose conveying compressed air, steam, gas, or fluid breaks or becomes disconnected by accident or through faulty connections, it whips around in a dangerous manner. With the Murray-Lorge automatic shut-off valve placed in the supply line above the flexible hose, the air, steam, or other fluid supply is automatically shut off by this valve immediately upon the hose breaking or becoming disconnected. When repairs or connections are made the valve automatically re-opens.

The use of this valve permits tools to be changed without shutting off the supply of compressed air or steam. When the workman connects up a different tool, the valve re-opens automatically upon the pressure in the flexible hose becoming equalized with the pressure at the valve inlet.



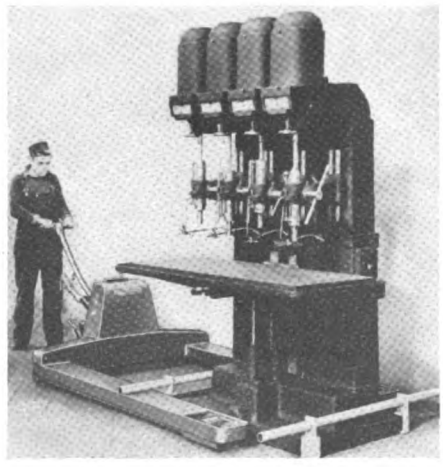
Cut-away view of the Murray-Lorge automatic safety shut-off valve

The integral parts of the valve are shown in the illustration. As long as the pressure at the inlet and outlet are nearly the same, the plunger is maintained in an open position by means of a spring, permitting the air or steam to flow around the plunger in a normal manner. When the outlet is left wide open, the plunger slides tightly against the valve seat shutting off the flow from above the plunger. The valve plunger may be adjusted to shut off the flow of air or steam automatically at any desired pressure at the inlet or size of break at or below the outlet.

This valve is a safety appliance designed by the D. J. Murray Mfg. Co., Wausau, Wis.

Lift Truck Handles Machine Tools

An open-end hydraulic lift truck designed especially for machine tools has been developed by the Lewis-Shephard Sales Corp., Watertown, Mass. With this adaptation of the lifting platform, cumbersome machine tools with a large variety of base sizes may be handled by this truck. The demountable clamps on the drill press, shown in the illustration, painted white, are the manufacturer's own device. Other types of clamps or eye-bolts may be used as effectively.



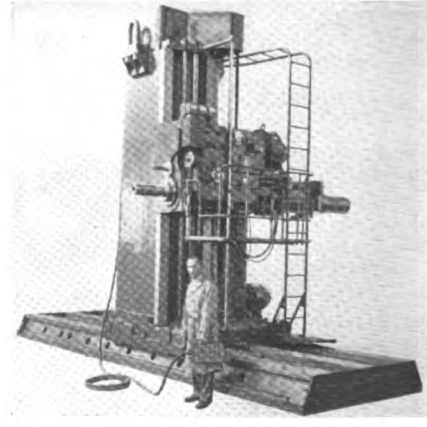
Lewis-Shepherd open-end hydraulic lift truck of 6,000-lb. capacity handling a drill press

The truck has hydraulic-foot-lift elevation, a platform length of 78 in. and an over-all width of 60 in. It is equipped with rubber tires and a trailer hitch that permits tractors or power trucks to haul this truck with its load. The trucks are obtainable in capacities from 3,500 to 15,000 lb. and over.

Boring, Drilling and Milling Machines

The Giddings & Lewis Machine Tool Company, Fond du Lac, Wis., will make available to industry a heavy-duty design of high power, horizontal boring, drilling, and milling machines with the announcement of its 50-series line.

The first machine of this new series to be built was a floor-type machine having a main spindle diameter of 6 in. and an auxiliary spindle diameter of 2½ in. A 96-in. head-stock travel and 192 in. of column travel on the runway were two of the dimensional specifications. The over-all height of the completed machine was approximately 18 ft., while the height of the complete unit was 85,000 lb.



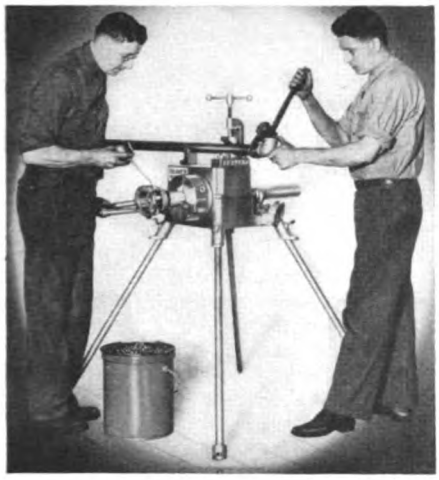
Giddings & Lewis 50-series floor-type machine —It has a portable remote-control station

Among the standard features of the manufacturer's equipment incorporated in this series are the two-spindle design, in-

dependent operation of units, rotary-feed selector, wide range of boring and milling feeds, direct reading dials, automatic depth gage, safety limit switches, scales and adjustable verniers. Particular attention has been given to the design of electrical controls for greater flexibility and ease of operation. A portable or remote control station in addition to the regular control station located on the operator's platform is furnished as shown on the accompanying illustration. The 50-series will be available in table, floor and planer types with working ranges to meet specific requirements.

Portable Threading Machine

Model-C is the designation for a new portable threading machine produced by Beaver Pipe Tools, Inc., Warren, Ohio. It has a motor-driven chuck of sufficient capacity



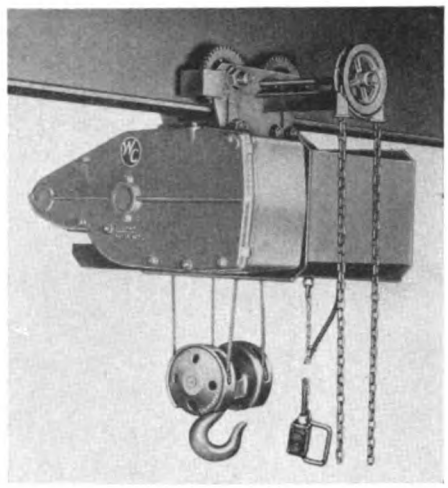
The Beaver Model-C portable threading machine

to thread 2-in. pipe with full-width solid dies or to act as the driving unit for geared pipe-cutting heads to 8 in. capacity. The machine can be supplied as a single unit or with a vise and bending head as shown in the illustration.

The driving motor is a Black & Decker unit rated at ½ hp. and available for operation on 110 or 220 volts, ac. or dc. A reversing switch is part of the equipment. The chuck is a standard design and will grip pipe from ⅛ in. to 2 in. in size. At the side of the housing is an extension bar lying parallel with the axis through the chuck to act as a back stop for the handle of a threading tool.

Electric Hoist for General Shop Service

The electric hoist shown in the illustration is one of a line of motor-operated hoists with push-button control built by the Whiting Corporation, Harvey, Ill. These hoists



Whiting type WFBG electric hoist with push-button control and chain-operated geared trolley

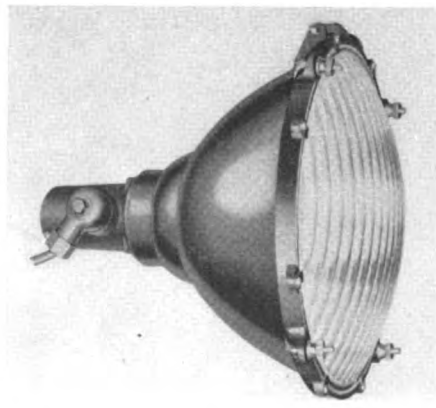
have a welded all-steel frame to which is bolted a cast gear case containing the reduction gearing and the load brake. The frame is furnished with a built-in steel trolley or with lugs or hooks for suspension, or it may be designed for floor mounting.

The trolley may be plain or geared and the geared trolley may be furnished with either a chain or motor drive. Low headroom is obtained in these hoists by mounting the drum parallel with the track and allowing the hook block to come up along side of the drum. This construction prevents any unbalancing when reaching for loads since the pull is always tangent to the drum.

These electric hoists are available with capacities ranging from 1,000 to 15,000 lb. and lifts of from 20 to 40 ft. The manufacturer also builds models having a pendent rope control.

Lighting Unit Resists Corrosion

To meet the need for a local floodlighting unit able to withstand severe vibration and



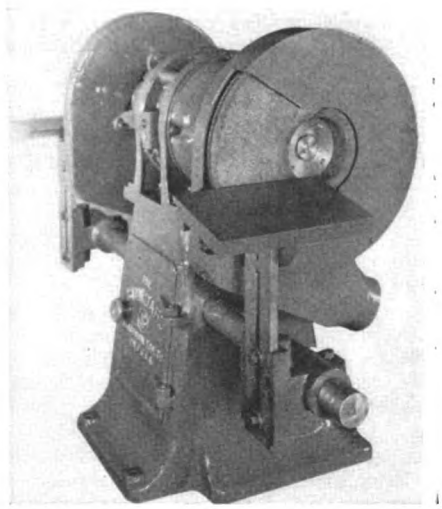
Westinghouse Tufflite Concentrators withstand vibration and corrosive atmospheric vapors

resist deterioration from corrosive atmospheric vapors, the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has developed the Tufflite Concentrator, a unit using either a 300- or 500-watt PS-40 Mazda lamp. These concentrators are of particular value in railroad enginehouses.

The complete unit consists of a copper housing, inner Alzak aluminum reflector, cast bronze socket-housing assembly, swivel for ¾-in. conduit mounting, and a glass-cover door assembly. All hardware is bronze or copper, nickel plated. The heat-resistant glass spread lens is held securely in place against a graphitized asbestos gasket by eight bronze spring clips fastened with machine screws.

Double-End Disc Grinder

The double-end disc grinder shown in the illustration is a new item in the line of equipment made by the Standard Electrical Tool Co., Cincinnati, Ohio. It is mounted on a cast-iron pedestal and has a



The five-horsepower Standard double-end disc grinder with 18-in. diameter discs

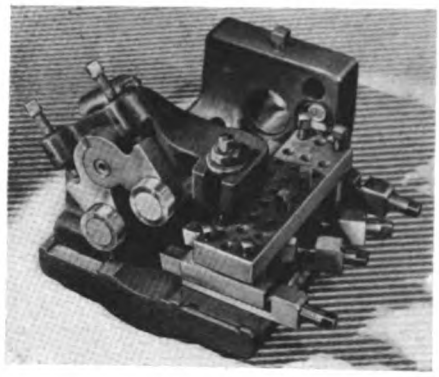
direct motor drive. Located inside the base is a magnetic starter having overload and under-voltage protection with a push-button station installed at the front of the machine convenient to the operator. The grinder is furnished with heavy-duty ball bearings, fully protected by a sight-feed oil gage on each bearing housing in order that the oil level may be easily determined at all times.

A plain swivel table on each side of the machine is supported by a heavy one-piece rocker arm bar extending through both sides of the pedestal. When required, the grinder can be furnished with a universal table on one or both sides. The steel discs are accurately machined and balanced and it is optional for the user to employ steel-back emery discs or to apply the emery discs with glue by use of the disc press. The disc wheels are protected

with an exhaust pipe and fabricated boiler-plate steel guards. The discs are available in sizes from 10 to 30 in. in diameter.

Multiple Cutter Turner

A multiple cutter turner for turret lathes has been announced by the Gisholt Machine Company, Madison, Wis. The cutter turner makes several reducing cuts simultaneously. Among the design features of this tool which contribute to its ability to make heavy high-speed cuts and still maintain exact dimensions and fine finish are its rigid steel construction, hardened steel rollers mounted on roller bearings, and adjustable roller arms that attach securely to the block.



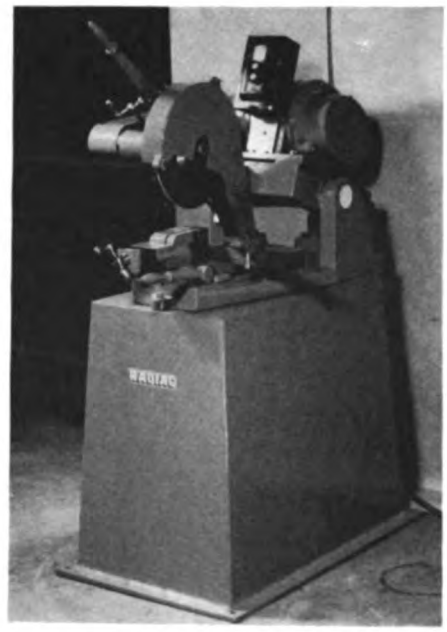
The Gisholt multiple cutter turner, a turret lathe tool for making several cuts simultaneously

Set-up operations are facilitated by the micrometer adjustment screws on the tool blocks. All movable parts are adjustable for wear and are enclosed to exclude chips and dirt. This turner is available in several sizes which permit turning diameters as small as ¾ in. and as large as 4¾ in. The multiple cutter turner, illustrated, will turn one to four or more diameters at one time. Individual or multiple tool blocks are available.

Dry-Cutting Cut-Off Machine

The Radiac Type M cut-off machine is being introduced by A. P. DeSano & Son, Inc., Phoenixville, Pa., for dry-cutting only. This machine is of the heavy-duty bench type, using a disc 12 in. in diameter by 1/16, 3/32 or 1/8 in. in thickness. It has a five-horsepower motor with a five Vee-belt drive. It is furnished with two sets of interchangeable wheel flanges, a special angular depth adjustment with a quick-acting locking device, and a special work clamp for holding stock within the capacity of the machine. The vise opens up to a width of 2½ in. between the jaws.

The work is clamped in the vise by means of the spring tensioned jaws. A hand lever is used to release the stock quickly. The machine and clamping device are mounted on a steel base. It may also be obtained without the base for mounting on a bench.



The Radiac Type M cut-off machine on a steel base—It may be mounted on a bench

Machine for Milling Keyways and Splines

The Sundstrand hydraulic Rigidmil is designed to mill keyways and splines in shafts ranging in size from 2 in. to 10 in. in diameter and up to 10 ft. in length. The keyways range from ½ in. to 2¼ in. in width and are machined to .002-in. limits. On this machine the fixtures can be adjusted easily so that the keyways and splines can be cut to any length on the shaft after the work is placed between the headstock and tailstock. The machine weighs approximately 40,000 pounds. It is built by the Sundstrand Machine Tool Co., Rockford, Ill.

The base member and column are of welded-steel construction. A horizontal head attached to the column ways has a 12-in. vertical adjustment and has a single spindle that is mounted in a quill with a 3-in. end-wise adjustment. This head also has ways on which the vertical spindle head is mounted, these ways furnishing a crosswise adjustment of 5 in. The vertical spindle is mounted in a quill having a 6-in. vertical adjustment.



The Sundstrand hydraulic Rigidmil for milling keyways and splines in shafts

The horizontal end is raised and lowered by means of a hand wheel that has a micrometer dial graduated to .001 in. The machine table has a working surface of 22 in. by 186 in. and has a travel of 132 in. in either direction with power feed or rapid traverse. The table is operated hydraulically at speeds of ½ to 10 in. per min. and in rapid traverse at a rate of 85 in. per min.



The Dexter lapping outfit, by using a special yoke and handle, enables the operator to lap globe valves with Stellite seats easily and efficiently—It is made by the Leavitt Machine Company, Orange, Mass.



. . . is as important as accurate wheel making. A perfect wheel, eccentrically mounted, is certain to develop defects. The concentricity gage developed by our Research Laboratory and used by our Association members for all wheel mounting adds one more safeguard to proper assembly and provides a positive check on mounting practise.

You, too, will find this simple device invaluable. We will be glad to send a complete description at your request.

4 Savings with Chilled Car Wheels

1. **Lowest cost per mile.**
2. **Increased rail life.**
3. **Increased brake shoe life.**
4. **Reduced machine shop costs.**

ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS

230 PARK AVENUE,
NEW YORK, N. Y.

445 N. SACRAMENTO BLVD.,
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AMCCW

ORGANIZED TO ACHIEVE:
Uniform Specifications
Uniform Inspection
Uniform Product

High Spots in

Railway Affairs . . .

Railroad Employment Still Climbing Up

The latest figures for railroad employment when we went to press were for mid-August. According to the Interstate Commerce Commission figures, based on preliminary reports from the carriers, there were 1,050,254 employees at that time. This was 5.4 per cent greater than for August, 1939. The largest increase over a year ago was in the maintenance of equipment and stores group, which was up 9.73 per cent. Next in order was the train and engine service group with an increase of 5.68 per cent. The maintenance of way and structures group showed an increase of 4.91 per cent.

A Railroad Executive Who Knew Machine Tools

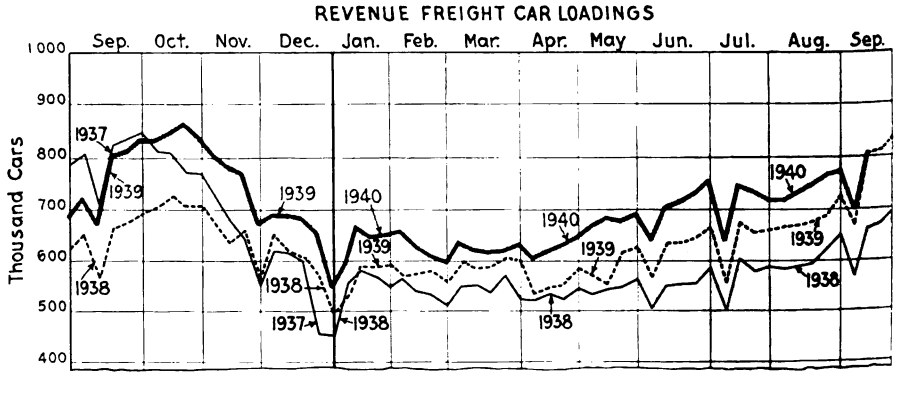
Leonor Fresnel Loree, who passed away on September 6, was one of the most energetic and colorful railroad executives and financiers in this country, or in the world for that matter. Comparatively few people, however, knew of his keen and exceedingly intelligent interest in mechanical department affairs. It was always a fascinating experience to be invited to drop over to his office for a little chat. One never knew quite what to expect when courteously ushered into his commodious office. On one occasion he said he was interested in the rehabilitation of a locomotive repair shop on one of the systems with which he was associated. What could I tell him about the latest and most efficient machine tools and shop equipment? I quickly discovered it must be something we had not described in our columns, for he was thoroughly familiar with what had already been published. And when I say familiar, I mean just that, for he knew pretty well all there was to know about the merits of the particular machine or device. My surprise was even greater when he referred to the early history and development of some of the tools. He proved to be thoroughly at home with the writings of Prof. J. W. Roe in that field. This may not be so strange, however, when we remember that it was Loree who introduced the Newcomen Society into America. That organization is a British Society that has specialized in a study of the beginnings and history of engineering and industry. Made up in England of men more of the antiquarian type, the movement in this country is sponsored by leading industrial, transportation and business executives and engineers, with a generous sprinkling of engineering educators. Interestingly enough, however, one thinks of Loree as more closely resembling the British group, because of the unusual degree to which he pursued and dug up historical facts about the early beginnings of American transportation and industry. He did much to encourage research in and was thoroughly at home in that field. His interest in mechanical department problems, however, was much broader than this.

How Many Pieces in A Car or Locomotive?

Mr. Loree had a keen conception of the necessity for and possibilities of reducing the cost of maintenance of railroad equipment. Obviously the smaller the number of parts in a car or locomotive, the less the likelihood of their getting out of adjustment and causing trouble. It would not be quite fair to say that Mr. Loree made an obsession of this, but he was deeply concerned to see how far the number of parts in a given piece of equipment could be reduced. With him it was almost like playing a game to see how many parts could be eliminated when a new order for a class of cars or locomotives was put through. Every bolt, every nut, every rivet, every pin was counted as a part. If a casting could supplant a built-up structure, or if welding could be used, it meant a real gain. Sight was not lost, however, of the fact that this must not be carried so far as to interfere with the ready replacement of a part that was liable to be easily damaged or broken. I do not know, but I am wondering how far the "playing of this game" was responsible for Mr. Loree's persistent fight to introduce the all-welded locomotive boiler, which, incidentally, seems to have given an excellent account of itself. Naturally a government bureau is inclined to be over-cautious about countenancing any new development that may cause trouble. It is so much easier to be conservative than to stick one's neck out. At any rate, it took a lot of hard fighting on Mr. Loree's part to get permission to have such a boiler built and placed in service, and he is entitled to much credit for this innovation, although apparently the government is still keeping thumbs down on extending its use. Mr. Loree must also be given credit for the Delaware & Hudson experiments with high-pressure steam locomotive boilers. By many he was regarded as a member of the old school of railroad executives—a natural born fighter and a bit ruthless. But behind his gruff exterior was a big heart. His thoughtfulness for his men and their old age, his attempts to stabilize employment, and his keenness about the training of the workers marked him as one in the front ranks in the field of human relations in industry, though it must be admitted that this was not very generally recognized.

Human Limitations

One of the pathetic things that sometimes occur in these days of great organizations and multiplicity of duties is the fact that men of outstanding ability find themselves at the head of organizations of all sorts of experts whose findings they must pass upon and sponsor. No fair person will question the ability or fairness of Chairman Eastman of the Interstate Commerce Commission, formerly Federal Co-ordinator of Transportation. In the latter capacity he was faced with a tremendous amount of detail and quite naturally had to delegate a lot of responsibility to subordinates. He seems to have had almost unlimited confidence in them; or at least that would appear to be so, judging from some of their reports to which he subscribed and passed on to the public. This applies to the report on "Public Aids to Transportation." The Association of American Railroads has prepared a 16-page booklet in two colors, which points out the fallacies in his statements about the claim of over-payment by highway users. The Railway Age heads a news item about the booklet with the caption "Ethiopians in the Woodpile of Mr. Eastman's Scholarship."



(*Turn to next left-hand page*)

Keep the defense program rolling . . . .



Photo courtesy Southern Pacific Company

. . . with MODERN POWER

American industry is being called upon now to prepare for the most intensive production effort it has ever made. Production and transportation facilities will be pivot points on which this effort will hinge.

The Lima Locomotive Works is ready to supply the railroads with MODERN POWER . . . . power capable of moving heavier loads at the higher speeds that will be demanded.

LIMA LOCOMOTIVE WORKS INCORPORATED, LIMA, OHIO

NEWS

B. & M. Tries Experimental Diesel Freight Locomotive

THE big Diesel-electric freight locomotive developing 5,400 engine hp. built by the Electro-Motive Corporation at the beginning of the year for experimental operation and since operated on a number of roads, chiefly in the West, moved onto the lines of the Boston & Maine on September 5, where it has been used on trial runs on fast through freight trains. The locomotive, which consists of two locomotives of two units each coupled back to back, is 193 ft. long and weighs 912,000 lb. Its first job on the Boston & Maine was to haul a 4,500-ton, 83-car freight train in record-breaking time from the Mechanicville (N. Y.) yards to Somerville, Mass.

50-Ft. Box Cars Getting Scarce

BECAUSE of the "evident necessity for a general tightening up in the handling of 50-ft. box cars," Chairman W. C. Kendall of the Car Service Division, Association of American Railroads, has sent out a circular requesting all railroads to issue specific instructions "to your local people in order that all concerned in active car handling may be properly informed." In another place the circular suggests that "in any planning for additional equipment careful consideration should be given to the possible need for increasing the supply of 50-ft. cars."

"With car loadings gradually increasing week by week, the demands on the box car supply are growing proportionately," Mr. Kendall said. "A considerable volume of closed car traffic requires 50-ft. cars, particularly long-haul business from the far West, as well as an increasing amount of traffic in the East and Southeast. There is evidence already of much national defense traffic for which the large cubical capacity box cars will be required and this type of loading will rapidly increase through the Fall and Winter into next year."

"Quiz on Railroads and Railroading"

THE Association of American Railroads has recently issued for free public distribution a 68-page booklet entitled "Quiz on Railroads and Railroading" which contains 400 questions and answers on practically every query that a layman can make. Dedicated "to the curiosity of the American people" and published, among other reasons, for the relief of railroad men and women who are plied with questions every hour of the day, the booklet contains a number of fine "atmosphere" photographs and a complete detailed index which tracks down items by every conceivable reference and cross-reference.

Questions are classified according to theme. The book opens with general questions like: "What is the maximum grade on main line track?"; "What is the highest altitude reached by a railroad line in the United States?", and "What is the longest railroad curve in the United States?" Then come questions of a more technical nature such as "What is a derail?"; "What are the various kinds of railroad yards?"; "What is the weight of a steam locomotive?", etc. Further classifications include railway operations, passenger service, head-end traffic, freight service, organization and personnel, investment and capitalization, taxes, railroads as buyers and railway history. In scope, the

(*Continued on second left-hand page*)

Orders and Inquiries for New Equipment Placed Since the Closing of the September Issue

LOCOMOTIVE ORDERS

Road	No. of locos.	Type of loco.	Builder
Baltimore & Ohio	7	2,000-hp. Diesel-elec.	Electro-Motive
Boston & Maine	3[1]	4-8-4 type	Baldwin Loco. Wks.
Chattanooga Traction Co.	2	350-hp. Diesel-elec.	General Elec. Co.
C. M. St. P. & P.	3	1,000-hp. Diesel-elec.	Electro-Motive Corp.
	9	600 hp. Diesel-elec.	
	4	1,000-hp. Diesel-elec.	American Loco. Co.
	2	1,000-hp. Diesel-elec.	Baldwin Loco. Wks.
C. St. P. M. & O.	2	Diesel-elec.	Electro-Motive Corp.
	1	Diesel-elec.	American Loco. Co.
D. M. & I. R.	8[3]		Baldwin Loco. Wks.
E. J. & E.	2	1,000-hp. Diesel-elec.	Electro-Motive Corp.
	6	600-hp. Diesel-elec.	
	2	1,000-hp. Diesel-elec	American Loco. Co.
	2	600-hp. Diesel-elec.	
	3	660-hp. Diesel-elec.	Baldwin Loco. Wks.
Gulf, Mobile & Ohio	2[2]	2,000-hp. Diesel-elec.	American Loco. Co.
Seaboard Air Line	1[3]	2,000-hp. Diesel-elec.	Electro-Motive
United States Navy Dept.	1	Diesel-elec.	Gen. Elec. Co.

LOCOMOTIVE INQUIRIES

Southern	2	600-hp. Diesel-elec.	.....

FREIGHT CARS

Road	No. of cars	Type of car	Builder
Atlantic Coast Line	600	Auto-box	Pull.-Std. Car Mfg. Co.
	15	Covered hopper	
	100	Auto. furniture	Mt. Vernon Car Mfg. Co.
	50	Stock	
	500	Hopper (coal)	Bethlehem Steel Co.
	200	H. S. gondolas	
	100	Gondolas (phosphate rock)	
	125	Flat	Greenville Steel Car Co.
Canadian Pacific	100	Drop-end gondolas	Canadian Car & Fdry. Co.
	100	Drop-end gondolas	National Steel Car Co.
	300	Hopper	
Chicago, Indianapolis & Louisville	100[4]	50-ton hopper	Pull.-Std. Car Mfg. Co.
C. R. I. & P.	800	Box	Pressed Steel Car Co.
	200	50-ton box	American Car & Fdry. Co.
	100	Drop-end gondolas	Pull.-Std. Car Mfg. Co.
Erie	325	Mill-type gondolas	Company shops

FREIGHT-CAR INQUIRIES

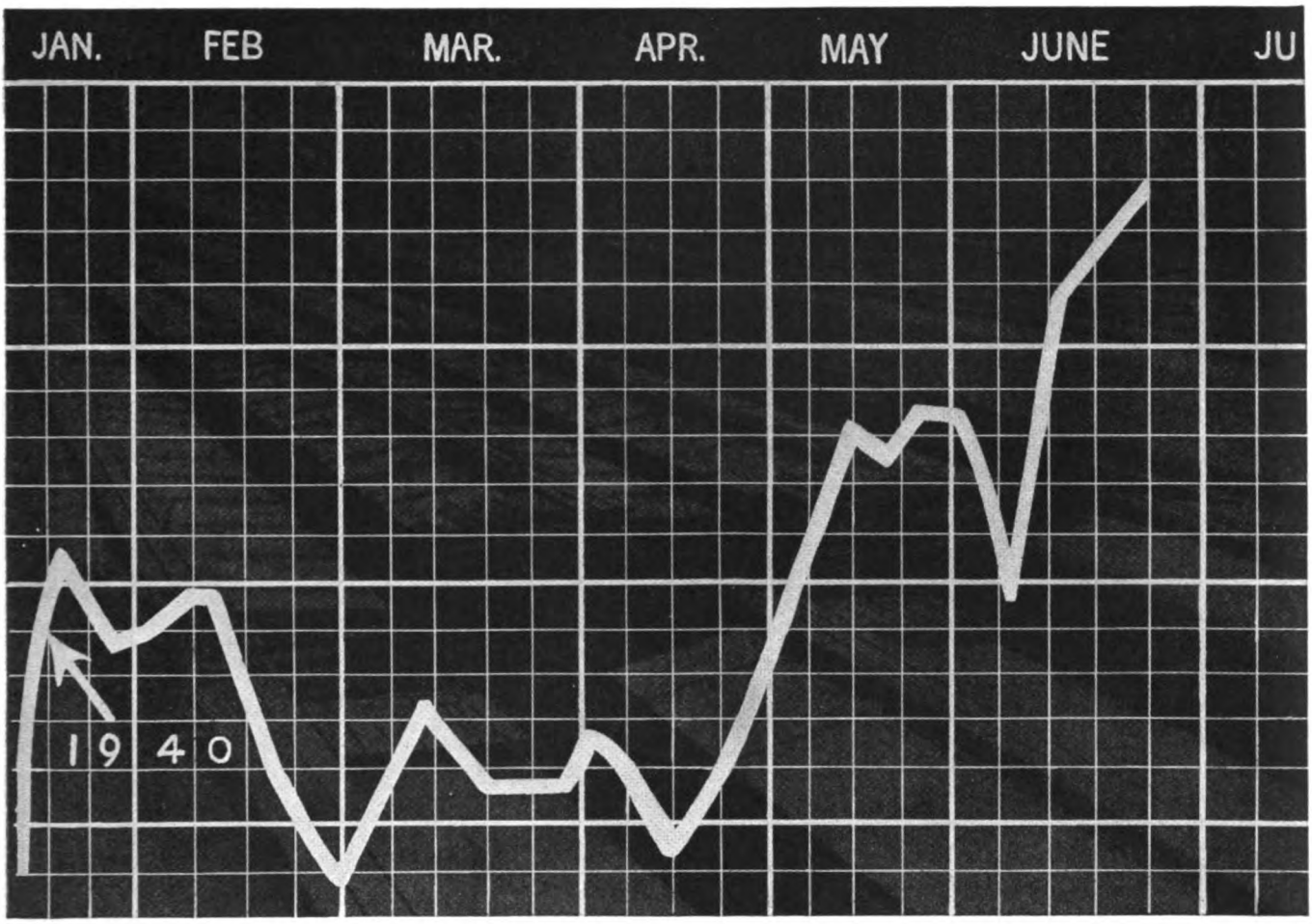
D. M. & I. R.	100	50-ton gondolas	.....
	30	50-ton ballast	.....
	10	70-ton hopper	.....
Southern	1,500	40-ton box	.....
	750	50-ton hopper	.....
	500	H. S. 50-ton gondolas	.....
	250	L. S. 50-ton gondolas	.....
Union Pacific	2,000	Underframes[5]	.....

PASSENGER-CAR ORDERS

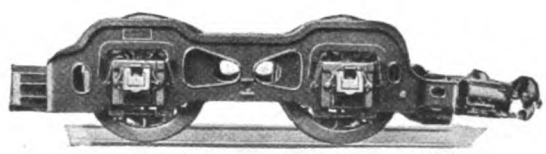
Road	No. of cars	Type of car	Builder
Canadian Pacific	10	Bagg.-exp.	Canadian Car & Fdry. Co.
	25	Steel frames[6]	
Pennsylvania	3[7]	Coaches	Edw. G. Budd
Seaboard (in conjunction with Pennsylvania)	10	Coaches	Edw. G. Budd[8]
	2	Diner-lounge	
	3	Tavern-obser.	
	3	Pass.-bagg.-domitory	

[1] To cost approximately $160,000 each.
[2] Delivery taken. For "Rebel" service.
[3] Total value approximately $2,000,000. To haul "Silver Meteor" equipment between New York and Florida. The locomotive ordered was built last year and is now on display at the General Motors exhibit at the New York World's Fair.
[4] In addition to 100 reported in the September issue.
[5] For box cars to be built in company shops.
[6] For first-class coaches to be built at Angus shops.
[7] Lightweight stainless-steel coaches to be operated jointly with the 17 similar units ordered by the Atlantic Coast Line, as reported in the September *Railway Mechanical Engineer*.
[8] To go into service between New York and both coasts of Florida starting in the late fall.

CARLOADINGS ARE ALREADY UP!



Already the preliminary stages of the defense program have resulted in an increase in carloadings. When the program is under full swing the railroads will be faced with a hauling problem such as they have not faced in years. » » » The quickest and most economical means of meeting the demand of moving heavier loads at high speeds with your existing locomotives is . . . BOOSTER* POWER! The Locomotive Booster, by capitalizing idle weight and spare steam, enables you to start heavier loads and keep them moving over the ruling grades. Increase the capacity of what already exists by adding the Booster.



*Trade Mark Registered United States Patent Office

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK
CHICAGO
MONTREAL

7 Million Miles

OF SUCCESSFUL OPERATION HAVE PROVED THE SECURITY CIRCULATOR

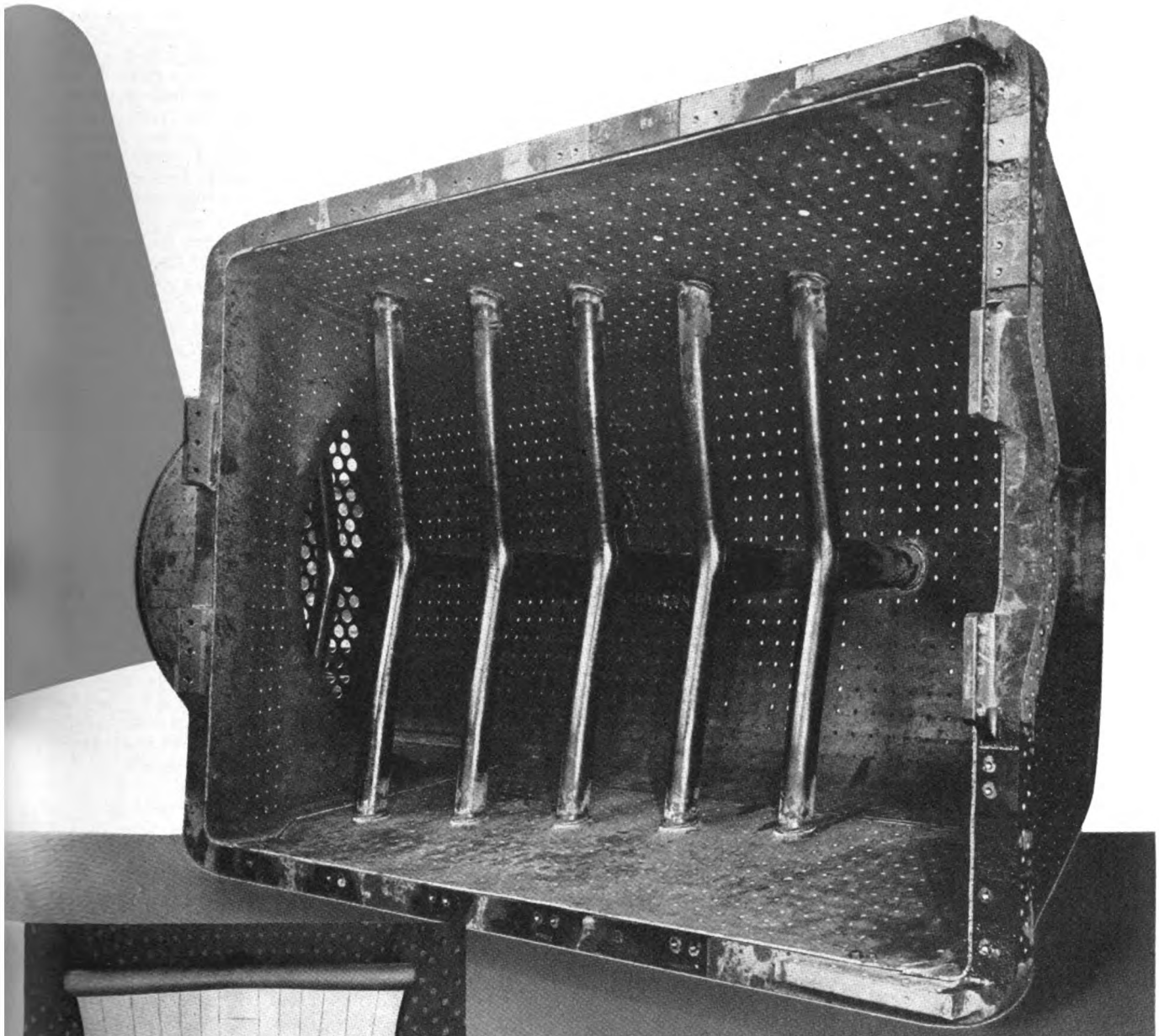
564 Security Circulators (371 of which were installed during the past 12 months) are operating on 20 railroads and have accumulated over 7 million locomotive miles, mostly in heavy, fast freight and passenger service. » » Some of these Circulator-equipped locomotives have operated over 300,000 miles. » » The Security Circulators in service have proved so successful that repeat orders are constantly being placed.



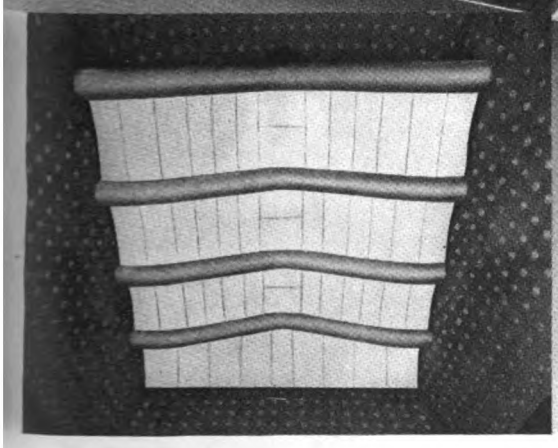
View illustrating the positioning of Security Circulators in an average size of locomotive firebox prior to installing the brick arch.

AMERICAN ARCH

Security Circulator Division



Firebox of one of ten 4-8-4 type locomotives recently built for a mid-western road — all equipped with Security Circulators.



Typical Security Circulator and brick Arch Installation in a locomotive firebox. The small sectional brick are as readily applied as in an ordinary arch tube firebox.

- ★ **Improved Arch Support for the largest fireboxes**
- ★ **Adapted to any type of locomotive**
- ★ **Reduced honeycombing, flue plugging and cinder cutting**
- ★ **Improved circulation in side water legs**

COMPANY, INC.

NEW YORK **CHICAGO**

questions range from the simplest—as "What is a railroad cut?"—to a discussion of the handling of disputes between railroads and their employees. The cover painting is taken from the latest calendar issued by the Committee on Public Relations of the Eastern Railroads.

Equipment Purchasing and Modernization Programs

Bessemer & Lake Erie.—Work will be carried out by company forces on an extension to machine and erecting shop and rearranging conduits and pipe lines at Greenville, Pa., at a cost of approximately $72,000.

Canadian National.—A contract has been awarded to the Fundy Construction Company, Ltd., Halifax, N. S., for the construction of a new locomotive enginehouse at Fairview, N. S.; estimated cost $100,000.

Chicago, Rock Island & Pacific.—New terminal facilities for handling Rocket trains to be placed in service this fall between Memphis, Tenn., and Amarillo, Tex., are being constructed at Memphis at a cost of approximately $32,000. The new facilities will consist of a transfer table, a drop pit, two inspection pits, an 8,000-gal. fuel oil tank and water, steam and air extensions.

Duluth, Missabe & Iron Range.—This road has applied to the Interstate Commerce Commission for authority to assume liability for $1,500,000 of 1½ per cent equipment trust certificates to finance in part the acquisition of rolling stock to cost $2,089,200.

Seaboard Air Line.—The S. A. L. has asked the Interstate Commerce Commission to approve a plan whereby the Reconstruction Finance Corporation would either guarantee or purchase $1,120,000 of three per cent equipment trust certificates, maturing in 14 equal annual installments beginning November 1, 1941. The proceeds would be used to finance in part the purchase of 15 streamline passenger cars, 50 70-ton all-steel hopper cars, and one 2,000 h.p. Diesel-electric locomotive unit, costing a total of $1,373,475. The petition states that the passenger cars will be purchased from the Edward G. Budd Manufacturing Company, the hopper cars from the Pullman-Standard Car Manufacturing Company, and the locomotive unit from the Electro-Motive Corporation.

Supply Trade Notes

J. G. FORSTER, vice-president of the Ogle Construction Company, Chicago, has also been elected vice-president in charge of sales of the Union Railway Equipment Company, Chicago.

◆

ROBERT G. ALLEN, whose election as president and a director of The Duff-Norton Manufacturing Company, Pittsburgh, Pa., was announced in the September *Railway Mechanical Engineer*, was born in Winchester, Mass., on August 24,



Robert G. Allen

1902. He attended Phillips Academy, Andover, and Harvard University, majoring in economics, and taking post-graduate work at Harvard Business School. Upon completion of his college courses, Mr. Allen obtained a job with the Walworth Company in South Boston, Mass., entering the foundries as a laborer to learn this phase of the business. From that department, he went to the machine shops, and then up through the other divisions of the company. In 1927, he was sent to Columbus, Ohio, to represent the Walworth Company in the sales field, and two years later was appointed sales manager, with headquarters at Greensburg, Pa. In 1936, Mr. Allen resigned to become a candidate for Congress. He was elected and served in the National House of Representatives for four years, during which period he served as a member of the Foreign Affairs Committee. After his re-election in 1938, he notified his constituents that he would leave public life at the expiration of his term and on July 15, 1940, he was elected president of the Duff-Norton Manufacturing Company, Pittsburgh, and also of its subsidiary company, the Canadian Duff-Norton Company, Ltd., Coaticook, Que.

◆

THE BETTENDORF COMPANY, Bettendorf, Iowa, is rearranging and modernizing its plant facilities to increase and accelerate production. Core rooms, molding and shake-out rooms are being moved and re-equipped for assembly line operation. New furnaces are being built, conveyor systems installed and chemical and metallurgical laboratories erected. The cost of the new equipment and the rearranging of facilities is $500,000.

◆

FRANK R. CARLSON, manager of sales of the Chicago Railway Equipment Company, Chicago, has been elected vice-president in charge of railroad sales.

◆

CHICAGO PNEUMATIC TOOL COMPANY.—*P. J. Christy* has been appointed manager of the Philadelphia (Pa.) office of the Chicago Pneumatic Tool Company, succeeding *A. M. Brown*, who has been transferred to Washington, D. C., as manager of a new branch opened in that city recently. *C. A. Diehl* has been appointed manager of the Houston (Tex.) office.

◆

GISHOLT MACHINE COMPANY.—*George M. Class*, chief engineer of the Gisholt Machine Company, Madison, Wis., has been appointed vice-president in charge of engineering. *Frederick L. Chapman*, assistant sales manager, has been appointed sales manager. *Roy Hunter* and *P. Robert Foseid* have been appointed to the sales force, Mr. Hunter being located at Cleveland, Ohio, and Mr. Foseid at Newark, N. J.

THE GOLD CAR HEATING & LIGHTING CO., located at 220 36th Street, Brooklyn, N. Y., for the last 20 years, is moving its offices to 33 Thirty-fifth Street in the same city.

◆

J. B. EMERSON, formerly engineer of tests for the rail committee of the American Railway Engineering Association and later associated with the passenger car axle research conducted by the A. A. R., Mechanical division, at the Timken Roller Bearing Company's laboratory at Canton, Ohio, has become affiliated with the Pittsburgh Testing Laboratory's railroad inspection department, with headquarters in Chicago.

◆

JOHN E. STAPLETON, assistant to the vice-president in charge of sales of the Carnegie-Illinois Steel Corporation, has been appointed assistant manager of sales,

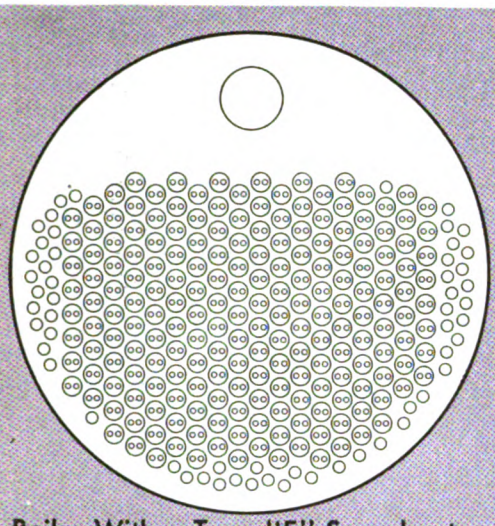


John E. Stapleton

New York district. Mr. Stapleton attended the University of Cincinnati (Ohio) and entered service with the Carnegie Steel Company in 1917. From 1921 to 1926 he served as a salesman in the Kentucky coal fields, and for the next eight-year period

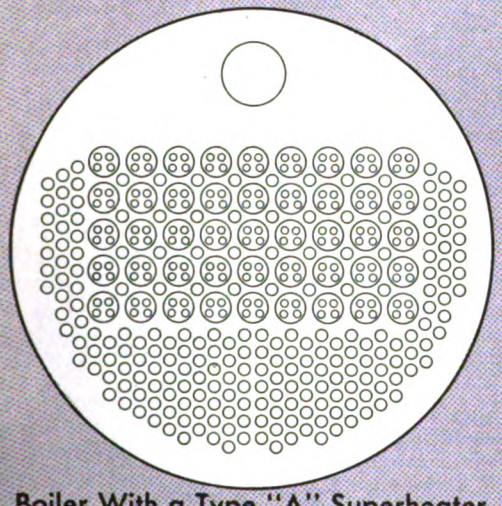
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Maximum Boiler Horsepower



Boiler With a Type "E" Superheater

ITEM	SUPERHEATER Type "A"	SUPERHEATER Type "E"	Increase	Increase Per Cent
Tube and flue heating surface...	4,200 sq. ft.	4,641 sq. ft.	441 sq. ft.	10.5
Superheating surface	1,164 sq. ft.	2,088 sq. ft.	924 sq. ft.	79.3
Gas area	1,337 sq. in.	1,374 sq. in.	37 sq. in.	2.76
Steam area	51.3 sq. in.	67.06 sq. in.	15.76 sq. in.	30.7



Boiler With a Type "A" Superheater

The steam generating capacity of a boiler is directly proportional to the amount of evaporating surface in square feet for equal length of tubes.

The tabulation compares two typical boilers in actual service, with the same outside diameter and length, as illustrated, one designed for the Type "E" superheater and the other for the Type "A" superheater.

The increase in evaporating and superheating heating surfaces made possible with the Type "E" superheater design in the same size of boiler, is substantial and is responsible for an increase in the steam generating capacity of the boiler.

Specify boilers with Elesco Type "E" superheaters for maximum boiler horsepower.

ELESCO

SUPERHEATERS • FEEDWATER HEATERS
AMERICAN THROTTLES • STEAM DRYERS
EXHAUST STEAM INJECTORS • PYROMETERS

THE SUPERHEATER COMPANY

Representative of
AMERICAN THROTTLE COMPANY, INC.
60 East 42nd Street, NEW YORK
122 S. Michigan Ave. CHICAGO
• • •
Montreal, Canada
THE SUPERHEATER COMPANY, LTD.

was resident salesman at Columbus, Ohio. He was resident salesman at Youngstown, Ohio, from 1934 to 1936, when he was appointed assistant to the manager of sales, with headquarters at Chicago. In February, 1938, he became assistant to the Carnegie-Illinois vice-president in charge of sales.

◆

J. THOMAS TALBOT, assistant to the president of the Brake Shoe and Castings Division of The American Brake Shoe and Foundry Company, has been appointed vice-president in charge of eastern sales of this division and of the Southern Wheel Division. After graduating from the McDonogh School, Baltimore, Md., in 1913, Mr. Talbot entered the service of the Baltimore & Ohio as a special apprentice, later serving as a machinist and locomotive inspector. In May, 1917, he enlisted in the 19th Engineers (railway), serving nineteen months overseas and receiving a commis-



J. Thomas Talbot

sion as second lieutenant. In March, 1919, he returned to the service of the B. & O. in the Cumberland, Md., shops. In June, 1920, he became an inspector in the employ of the American Brake Shoe and Foundry Company, with headquarters in New York. In 1923 he went to Norfolk, Va., as sales manager, and in 1935 returned to the New York office. In January, 1939, he was appointed assistant to the president of the American Brake Shoe and Castings Division.

◆

THE WHITING CORPORATION, Harvey, Ill., announces that it has acquired the 29-year-old Quickwork Company, manufacturers of rotary shears, stamping trimmers and forming machines, power hammers, throatless shears and flangers, formerly of St. Marys, Ohio, and Chicago. Stevens H. Hammond, vice-president of Whiting, will be in charge of all Quickwork operations, while Paul V. Hyland, formerly of the Industrial division of Whiting, has been appointed sales manager of the Quickwork line. B. W. Packer, formerly of the Quickwork Company, will join the new organization as chief engineer and S. M. Steinko will be in charge of advertising. All Quickwork products will be manufactured by the Whiting organization at its plant at Harvey.

Obituary

D. M. SMITH, assistant district sales manager, Chicago office of the Allegheny Ludlum Steel Corporation, died recently at his home in Chicago. Prior to the merger with Ludlum, Mr. Smith was district sales manager for the Allegheny Steel Company.

◆

WILLIAM B. HALL, president of the Union Railway Equipment Company, Chicago, died in that city on July 31. Mr. Hall was born in Nebraska City, Neb., on April 12, 1872. He entered railway service in 1891 in the operating department of the Chicago, Burlington & Quincy at Chicago and three years later resigned to accept a position with the Continental Illinois National Bank in Chicago. In 1896, he entered the employ of the Mather Stock Car Company in charge of purchases and production. Mr. Hall remained in the employ of this company until 1911. In 1912, he and two partners organized the Union Railway Equipment Company, Chicago. Subsequently, Mr. Hall acquired their interests.

◆

GEORGE N. VAN SWERINGEN, vice-president in charge of sales of the Chicago Railway Equipment Company, died on September 3 at Evanston, Ill. Mr. Van Sweringen was born at Ft. Wayne, Ind.,



George N. Van Sweringen

on April 9, 1875. He entered railway service with the Pennsylvania at Ft. Wayne, and later was employed by the Chicago, Rock Island & Pacific. In 1909, he became a sales representative for the Chicago Railway Equipment Company, and in 1926 was promoted to assistant to the president, which position he held until July, 1935, when he was elected vice-president in charge of sales.

◆

ABRAM LADUE WHIPPLE, district sales manager of The Standard Stoker Company, Inc., at New York, died on August 10. Mr. Whipple was born in Albany, N. Y., in 1872 and was educated at Highland grammar school, West Sommerville, Mass. He entered railway service in 1888 as telephone operator on the Fitchburg (now the Boston & Maine) and subsequently became chief clerk to the purchasing agent of that road. In 1892 he entered the railway supply business as a salesman for the Hopewell Railroad Supply Co., Boston, Mass., and later went with the Boston Woven Hose & Rubber Co. In 1895 he re-entered railroad service as assistant superintendent of the Hoosac Tunnel & Wilmington, Wilmington, Vt. Several years later he returned to the railway supply business as sales manager of the E. T. Burrowes Co., Portland, Me., which firm was later purchased by Chicago curtain interests and is now a part of Adams & Westlake Co. Subsequently he became assistant sales manager, Forsyth Brothers Co., Chicago, and later sales manager and vice-president of the Railway Equipment Company of New York (now Waugh Equipment Co.). In 1925 Mr. Whipple was appointed a representative of the Locomotive Stoker Company of Pittsburgh (Pa.) and became district sales manager of the Standard Stoker Co., Inc., at New York, in 1928, when the latter company purchased the patents of the Locomotive Stoker Company.



A. L. Whipple

◆

JOHN E. WARD, who was for many years associated with the car heating equipment business before his retirement in 1918, died at his home in Hackensack, N. J., on August 5, at the age of 65. He was born at Poughkeepsie, N. Y., on June 3, 1875, and rose through the ranks of the Gold Car Heating & Lighting Co. to become a vice-president. He resigned from the latter position in May, 1907, to form the Ward Equipment Company, manufacturers of heating and ventilating equipment, of which he became president. He later joined the Standard Heat & Ventilation Co., upon its absorption of the Ward Equipment Company, and in 1917 became an officer of the Vapor Car Heating & Lighting Co., which was an amalgamation of the Chicago Car Heating Company and Standard.

◆

CHARLES A. ROWAN, chairman of the board, of the Westinghouse Air Brake Company and the Union Switch & Signal Co., Wilmerding, Pa., died on September 13, at the age of 65, after several weeks' illness. Born in Pittsburgh, Pa., in 1874, Mr. Rowan was educated in the public schools of Pittsburgh and at Parnassus Academy. He began his business career as a bookkeeper at Logan's Planing Mills,

and two years later, in 1894, became a clerk in the employ of the East Pittsburgh Improvement Company. In 1902 he went with the East Pittsburgh National Bank. In 1903 he entered the service of the Westinghouse Air Brake Company, with which company he had since been engaged as assistant auditor, 1903-1909; acting assistant treasurer, 1909-1910; auditor, 1910-1916; comptroller, 1916-1919. In 1918,



C. A. Rowan

while comptroller, he was elected also vice-president. From 1930 to 1932 he was executive vice-president of Westinghouse, and from 1932 to 1936 was its president. During these latter years Mr. Rowan was also connected with subsidiaries of Westinghouse. In 1927 he became president of Westinghouse International Brake & Signal Co., which position he held until the dissolution of that organization in 1936. In 1929 he was also elected a director of Westinghouse and its affiliated Union Switch & Signal Co. Since 1936, Mr. Rowan had been chairman of the boards of Westinghouse and Union Switch.

◆

CHARLES A. CAMPBELL, engineer of tests, New York Air Brake Company, with headquarters at Watertown, N. Y., died of a



Charles A. Campbell

heart ailment at Watertown on September 4. Mr. Campbell was born in Harrisville, N. Y., in 1893, and received his early education in Montreal, Que. During school vacation periods as a medical student, he served as an apprentice draftsman with Allis Chalmers and Bullock, Ltd., where he became interested in mechanical engineering and adopted it as his profession. In 1910 he became a draftsman with the New York Air Brake Company, and a few years later was selected as an apprentice for the Experimental department, where he found background for the position of engineer of tests which he assumed in 1925 and held until his death. Mr. Campbell was honored as one of the nation's "modern pioneers" by the National Association of Manufacturers last February when it was brought out that he was the recipient of a total of 123 patents granted to him solely or jointly and had entered application for 16 additional grants. Among his outstanding contributions to the science of railroading are the development of a graduating type of retardation controller, known commercially as the Decelakron, and the electro-pneumatic straight-air controlled brake system. Other of his patents have influenced the development of the modern air brake for freight service, known as the AB brake, which has been adopted by the railroads for application to all cars in interchange service by 1945.

◆

C. M. HOFFMAN, who retired as vice-president of the Dearborn Chemical Company, Chicago, in 1936, died in Los Angeles, Cal., on September 9. Mr. Hoffman



C. M. Hoffman

was born in Moncton, New Brunswick, on July 29, 1870. He entered railway service as an apprentice on the Chicago, Burlington & Quincy at St. Joseph, Mo., and after serving as a machinist and foreman he was promoted to road foreman, from which position he resigned to become master mechanic of the Southern at Princeton, Ind. Five years later he became superintendent of motive power of the St. Louis, Brownsville & Mexico at Kingsville, Tex., and after another five years became master mechanic for the United Verde Mines at Clarkdale, Ariz. Later he served as master mechanic of the Denver & Rio Grande Western at Grand Junction, Colo.; master mechanic for the Utah Copper Company and superintendent of motive power of the Los Angeles & Salt Lake. In 1924, he resigned from the latter position to become Dearborn assistant to the vice-president of the Dearborn Chemical Company. In 1928 he was appointed vice-president in charge of railway sales.

◆

GEORGE E. SPENGLER, who had represented The Superheater Company and several other supply companies for many years in the Far East, died on August 9, in a San Francisco, Calif., hospital after a brief illness. He had just returned from China. Mr. Spengler was born in Chicago in 1882, and after attending schools in Chicago entered the service of the Chicago & North Western, becoming road foreman of engines. He left the service of the railroad to become a traveling engineer for The Superheater Company and during 1917 traveled to Russia as service representative in connection with the shipment of American-built locomotives. On his return to the United States he joined the Stevens Commission to investigate railroads in Manchuria. Thereafter, he made his home in China as representative of The Superheater Company and other American firms.

◆

O. W. BUENTING, vice-president in charge of manufacture of the Westinghouse Air Brake Company and the Union Switch & Signal Co., died on July 27, at Lewes, Del., after a brief illness. He had been vacationing at Rehoboth Beach. Mr. Buenting learned the machinist's trade on the Chicago, Burlington & Quincy at Wymore, Neb., and thereafter worked for several years in the shops of several western roads. In 1901 he was graduated from Purdue University with a degree in mechanical engineering; the subject of his thesis was the air brake. Immediately after graduation he entered the employ of the Westinghouse Air Brake Company as a special apprentice, and six years later became general superintendent of the Wil-

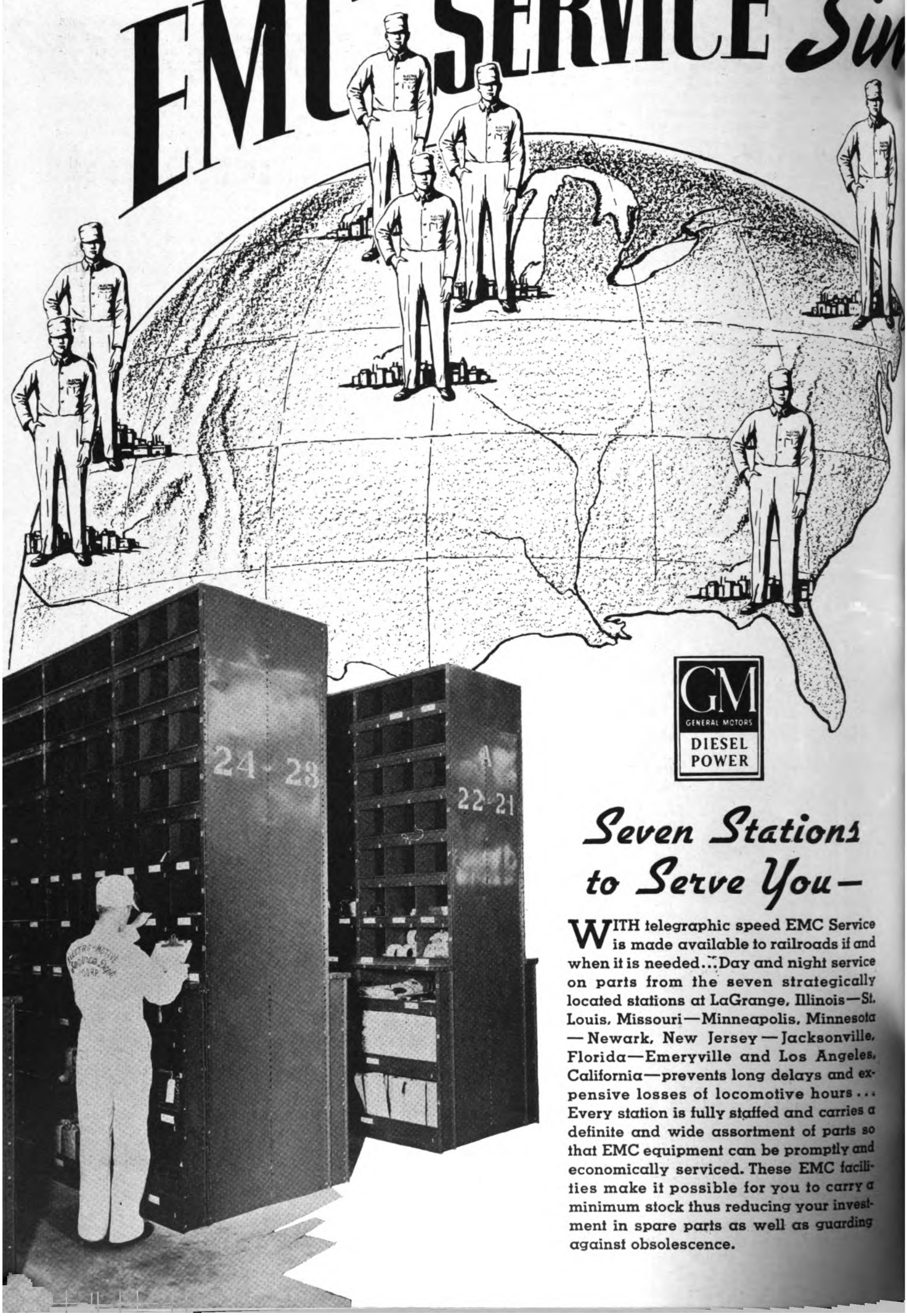


O. W. Buenting

merding (Pa.) plant in 1907. In 1917 he was promoted to works manager and in 1926 was appointed general manager of works for the air brake company and its subsidiaries. In 1930, Mr. Buenting was elected vice-president in charge of manufacture and in the same year was elected to a corrsponding position with the Union Switch & Signal Co., which position he held until his death.

(Turn to second left-hand page)

EMC SERVICE Sin



GM
GENERAL MOTORS
DIESEL
POWER

Seven Stations to Serve You—

WITH telegraphic speed EMC Service is made available to railroads if and when it is needed... Day and night service on parts from the seven strategically located stations at LaGrange, Illinois—St. Louis, Missouri—Minneapolis, Minnesota—Newark, New Jersey—Jacksonville, Florida—Emeryville and Los Angeles, California—prevents long delays and expensive losses of locomotive hours... Every station is fully staffed and carries a definite and wide assortment of parts so that EMC equipment can be promptly and economically serviced. These EMC facilities make it possible for you to carry a minimum stock thus reducing your investment in spare parts as well as guarding against obsolescence.

plifies Maintenance

EMC Nationwide Day and Night Service an Important Factor in High Availability For All EMC POWER . . .

IN the building of EMC Diesel locomotives, superior engineering technique, highest grade materials, the latest precision equipment and the most advanced manufacturing methods have been combined to minimize service needs. Back of every EMC Diesel motive power unit stands General Motors' undivided responsibility which guarantees every part of the equipment.

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Personal Mention

General

OTTO C. GRUENBERG, of the American Locomotive Company, has been appointed superintendent motive power of the New York, Ontario & Western and the New York, Susquehanna & Western.

L. W. DOWNEY, supervisor of automotive equipment of the Chicago Rock Island & Pacific, in charge of the maintenance of Diesel engines, has been granted a leave of absence, effective September 1, to serve as engineer of maintenance of the Diesel section of the Bureau of Ships of the U. S. Navy.

W. JOSEPH CRABBS has been appointed mechanical engineer of the Western Maryland, with headquarters at Hagerstown, Md., succeeding his father, William J. Crabbs, deceased. The newly appointed mechanical engineer was born on September 5, 1912, at Hagerstown and was graduated from Virginia Polytechnic Institute, Blacksburg, Va., with a B. S. degree in 1934. He entered railway service during the summer of 1927 with the Western Maryland and served during subsequent summers until 1933 as special apprentice. From June, 1934, to August, 1935, Mr. Crabbs served as special apprentice with the American Locomotive Company at Schenectady, N. Y. On August 1, 1935, he became draftsman for the Western Maryland and on March 8, 1938, he was promoted to chief draftsman, the position he held until his recent appointment.



W. Joseph Crabbs

Car Department

D. W. AKINS, general car inspector of the Texas & Pacific at Dallas, has been appointed superintendent of the car department.

WILLIAM SCHMALZRIED, superintendent of the car department of the Texas & Pacific at Dallas, Tex., has retired at his own request.

J. D. CLYDE, general foreman of the locomotive department of the Texas & Pacific at Ft. Worth, Tex., has become general car inspector at Dallas, Tex.

LEONARD R. SCHUSTER, whose promotion to engineer of car construction of the Southern Pacific, with headquarters at San Francisco, Calif., as announced in the August *Railway Mechanical Engineer*, was born at Napa City, Calif., on March 12, 1883, and studied a correspondence school course in mechanical engineering. He entered railway service in December, 1901, in the passenger car department at Sacramento, Calif., and in January, 1907, was transferred to drafting work in the motive power department at San Francisco. In 1915, after advancing through several positions, he was promoted to assistant chief car draftsman and three years later he was advanced to chief freight car draftsman. Mr. Schuster was promoted to chief car draftsman in 1924, the position he held until his recent promotion.



Leonard R. Schuster

Master Mechanics and Road Foreman

S. G. MATTICE, traveling fireman on the Canadian National at Saskatoon, Sask., has been promoted to master mechanic at that point.

G. H. WARNING, master mechanic of the Canadian National at Saskatoon, Sask., has been transferred to Regina, Sask.

Shop and Enginehouse

H. L. GEIDENBERGER, division foreman of the Baltimore & Ohio at Washington, Ind., has become superintendent of shops at Ivorydale, Ohio.

R. D. BRITTON, assistant locomotive foreman of the Canadian National at Jasper, Alta., has been appointed locomotive foreman at Calgary, Alta.

H. KONSIT, assistant locomotive foreman of the Canadian National at Vermillion, Alta., has become assistant locomotive foreman at Jasper, Alta.

Purchasing and Stores

A. R. MULLENS, assistant general storekeeper on the Union Pacific at Pocatello, Idaho, has been transferred to Omaha, Neb. The position of assistant general storekeeper at Pocatello has been abolished.

J. L. IRISH, assistant general storekeeper on the Union Pacific at Omaha, Neb., has been promoted to general storekeeper, with the same headquarters, succeeding U. K. Hall, whose retirement on March 31, was announced in the April issue of the *Railway Mechanical Engineer*.

E. O. HORNIG, assistant to vice-president in charge of purchases and stores, of the New York Central System, at New York, has been appointed assistant purchasing agent of the New York Central, the Indiana Harbor Belt and the Chicago River & Indiana, with supervision over the purchase of miscellaneous materials to be assigned.

E. S. BONNET, fuel purchasing agent of the New York Central and the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at New York, has been appointed first assistant purchasing agent of the New York Central, the Indiana Harbor Belt and the Chicago River & Indiana, at New York, with supervision over the purchase of fuel coal and forest products.

Obituary

J. C. LEWIS, road foreman of engines of the Richmond, Fredericksburg & Potomac and past president of the Railway Fuel and Traveling Engineers' Association, died of heart failure on September 18 at Richmond, Va.

WILLIAM J. CRABBS, mechanical engineer of the Western Maryland, with headquarters at Hagerstown, Md., died suddenly on August 13 from a heart attack, at the age of 61. Mr. Crabbs was born in Carroll County, Md., on June 12, 1879, and was graduated in mechanical drawing from the Maryland Institute for the Promotion of Mechanical Arts in 1905. He taught school from 1897 to 1902 and entered railroad service on May 22, 1902, as machinist apprentice on the Western Maryland, serving in that capacity until 1905, when he became draftsman. From 1907 to 1916, he was chief draftsman and from 1916 to 1917, motive power clerk. Mr. Crabbs was appointed mechanical engineer in 1918, the position he held until his death. He was a member of the Mechanical Division of the Association of American Railroads.

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General:

Five Mechanical and Supply Associations Hold Conventions and Exhibit 431
Allied Railway Supply Exhibit Breaks Record 509

Locomotive Maintenance Officers' Association:

Officers and Supervisors Discuss Locomotive Maintenance 432
Improving Railroad Service 433
Use of Machinery and Tools in Locomotive Repairs 435
Design, Operation and Maintenance of Diesel-Electric Locomotives 437
Future Locomotive Air Brake Maintenance 440
Locomotive Maintenance for Long Runs 443
Responsibility of the Locomotive Maintenance Officer and the Federal Inspector 444
Enginehouse Problems of the Present Day 446

Master Boiler Makers' Association:

Refined Practices Recommended at Master Boiler Maker's Meeting 450
The Master Boiler Maker—His Accomplishments and Opportunities 451
Some Problems of Boiler Maintenance 451
Some Neglected High Pressures 452
Oxy-Acetylene and Electric Processes in Boiler and Tender Work 453
Pitting and Corrosion on Firebox Sheets Back of Grate Bearers 457
Means to Improve Water Circulation in the Boiler 459
Treating Boiler Feedwater Chemically 462
Application of Iron, Steel and Alloy Rivets 463
Flues Cracking Through Bead—Tube and Flue Application 468
Cinder Cutting of Firebox Sheets, Flues, Tube and Smokeboxes 469
Maintenance of Tender Cisterns 471

Car Department Officers' Association:

Annual Meeting of the Car Department Officers' Association 472
Importance of the Car Department in Rail Transportation 473
Car Maintenance, Performance and Expense 474
Shop Operation—Electric Welding 475
Lubricants and Lubrication 477
Standard Classification Commodity Cards 478
Freight Car Maintenance 480
Report on Painting 483
Report on Loading Rules 484
Report on Interchange and Billing 485

Railway Fuel and Traveling Engineers' Association:

Fuel and Road Supervisors Discuss Equipment Operating Problems 487
Chief Dispatcher's Views on Fuel Economy 488
How Much Locomotive Fuel Can Be Saved 489
Utilization of Locomotives 490
Steam Consumption of Locomotive Auxiliaries 492
No. 8—ET Locomotive Brake Equipment 494
Developments in High Speed Braking 496
Oil Burning Firing Practice—A Trip With the Fireman 499
What Mechanical Cleaning Does to Fine Coal 500
Coal Equivalent of Fuels and Power 501
Coal Fired Stationary Boilers 503
Turbine and Condensing Locomotives 503
Handling Coal Fires in Smoke-Restricted Territory 504
The Road Foreman and the Diesel-Electric Locomotive 505

The Editor Looks at the Conventions:

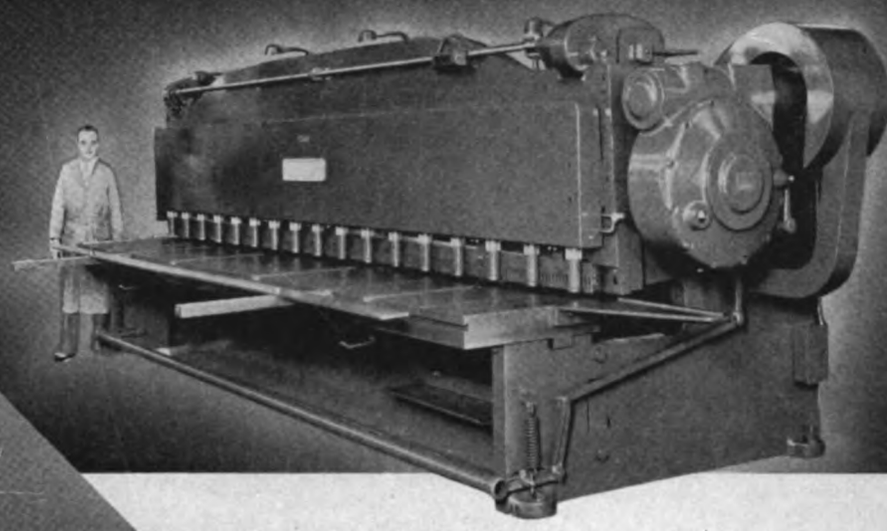
Start Meetings on Time 510
An Active Advisory Board 510
Mission of Guest Speakers 510
Manual for Procedures 510
Conservation of Human Resources 510
Roundhouse Foreman's Job 511
Every Railway Employee a Public Relations Representative 511
Ability to Express Yourself 511
Building Memberships 511
Use of the "Mike" 512
Stimulate Discussions 512
Enroll in Your Profession 512
The Co-ordinated Exhibit 512
Why Not the "Poor" Roads Too? 512
A Step in the Right Direction 513
Steam's Future—A Warning 513
Arbitrary Change in the Program 513
The Car Men's Meeting 514
Association's Work is Commended 514
Supplements A.A.R. Mechanical Division 514
Confusion in the Front Office 514

High Spots in Railway Affairs 515

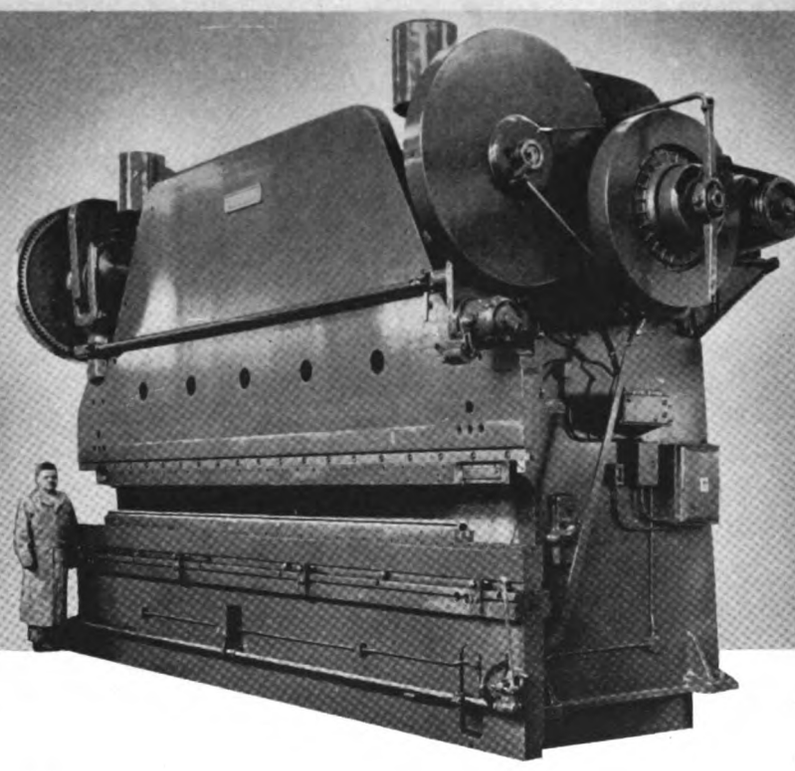
Clubs and Associations 516

News 517

Index to Advertisers ..... (Adv. Sec.) 62



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Five Mechanical and Supply Associations Hold Conventions and Exhibit

THE members of the four mechanical associations—Car Department Officers' Association, Locomotive Maintenance Officers' Association, Master Boiler Makers' Association and Railway Fuel and Traveling Engineers' Association—gathered at the Hotel Sherman, Chicago, for their four-day annual meetings, October 22 to 25 inclusive. The meetings were accompanied by an exhibit by 114 member companies of the Allied Railway Supply Association, Inc. At the opening session on Tuesday the members and guests assembled with the members of the Allied Railway Supply Association to hear an address by Colonel Robert S. Henry, assistant to president, Association of American Railroads. F. P. Roesch, chairman of the committee of the coordinated associations, presided at the assembly and introduced Colonel Henry. Colonel Henry's address will appear in a later issue. During the four-day meeting in which the four mechanical associations met in session separately many well known operating and mechanical officers made addresses and a number of individual papers and committee reports were presented and discussed. In the pages following the text of these addresses, papers and reports will be found, together with the high-spots of the discussions. Reports of the election of association officers are also included.

Officers and Supervisors Discuss

Locomotive Maintenance

Technical papers and addresses cover many phases of locomotive maintenance work in the back shop and enginehouse



F. B. Downey,
President



J. C. Miller,
First Vice-President



J. E. Goodwin,
Second Vice-President
and Secretary-Treasurer



F. J. Topping,
Third Vice-President

WITH a registration exceeding that of last year the annual meeting of the Locomotive Maintenance Officers' Association, held at the Hotel Sherman, Chicago, October 22 to 25 inclusive, will be remembered by those in attendance as marking a distinct step forward in the progress of the new association. The character of the attendance, including as it did a number of general mechanical officers and a comprehensive representation of the important supervisors in both the back shop and the enginehouse, is a definite indication that this association has succeeded in winning the support of the type of railroad man that will assure its future success. F. B. Downey, assistant shop superintendent, Chesapeake & Ohio, presided over the several sessions of the four-day meeting.

At the sessions the following papers and addresses were presented and discussed: What Members of the L. M. O. A. Can Do To Improve the Service on All Railroads, by C. B. Hitch, superintendent motive power, Chesapeake & Ohio; Design, Operation and Maintenance of Diesel-Electric Locomotives, by H. V. Gill, supervisor Diesel engines, Atchison, Topeka and Santa Fe; Future Locomotive Air Brake Maintenance, by J. P. Stewart, general supervisor of air brakes, Missouri Pacific Lines; Use of Modern Machinery and Tools in Locomotive Repairs, by D. J. Sheehan, superintendent motive power, Chicago & Eastern Illinois; Roundhouse Problems of the Present Day, by H. E. Hinds, assistant mechanical engineer, Burlington Lines, and Maintenance of Locomotive on Long Runs, by Lee Robinson, superintendent of equipment, Illinois Central.



D. S. Ellis,
Chief Mechanical Officer,
Chesapeake & Ohio



O. A. Garber,
Chief Mechanical Officer,
Missouri Pacific Lines



J. Roberts,
Chief of Motive Power and Car
Equipment, Canadian National

The members of the Association's 1940 Advisory Board

Roy V. Wright, editor, *Railway Mechanical Engineer,* who was called on during one of the sessions, paid tribute to the work that has been done by the association and its officers during the past two years and expressed the opinion that the time had now come to go out and sell the value of the association work to the mechanical officers and supervisors throughout the country with the object of increasing the membership. The present and potential members of the association, Mr. Wright said, are men who occupy important jobs in the railroad industry and they have every reason to look upon their work with the same feeling as professional men. Such an attitude will help to inspire the men who look to the officers and supervisors for leadership and training.

Over 500 members of the co-ordinated associations, supply representatives and guests attended a luncheon on October 24 given by this association in honor of the members of its Advisory Board, Messrs. Ellis, Garber and Roberts. The principal speaker at this luncheon was John M. Hall, director of the Bureau of Locomotive Inspection, Interstate Commerce Commission. Mr. Hall spoke on The Responsibility of the Locomotive Maintenance Officer and The Federal Inspector and in remarks preliminary to his address made an eloquent plea to railroad officers on behalf of the enginehouse foreman with respect to the long hours these men are required to be on duty. The text of Mr. Hall's address appears elsewhere in this issue.

Election of Officers

The following officers were elected for the ensuing year: President, J. C. Miller, general foreman, New York, Chicago & St. Louis (Nickel Plate), Conneaut, Ohio; first vice-president and secretary-treasurer, J. E. Goodwin, general foreman, Missouri Pacific, North Little Rock, Ark.; second vice-president, F. J. Topping, master mechanic, Chesapeake & Ohio, Hinton, W. Va.; third vice-president, S. O. Rentschler, general foreman, Missouri Pacific, Sedalia, Mo. Executive board members were elected as follows: For a one-year term: W. L. Rice, superintendent of shops, Reading Company, Reading, Pa.; F. W. Ekins, general foreman, Atchison, Topeka & Santa Fe, Chicago and J. P. Stewart, general supervisor of air brakes, Missouri Pacific, St. Louis, Mo.; for a two year term—E. J. Kueck, mechanical engineer, St. Louis-Southwestern, Pine Bluff, Ark.; W. P. Buckley, superintendent of shops, Chicago, St. Paul, Minneapolis & Omaha, St. Paul, Minn. and George Crowder, superintendent motive power, Georgia & Florida, Douglas, Ga.

Action was taken by the association to increase the membership of the Advisory Board to five members. G. C. Christy, general superintendent of equipment, Illinois Central, and D. J. Sheehan, superintendent motive power, Chicago & Eastern Illinois, were elected to that Board.

Improving Railroad Service

By C. B. Hitch

Superintendent Motive Power, Chesapeake & Ohio

The subject assigned to me—"What Members of the Locomotive Maintenance Officers Association Can Do to Improve the Service on All Railroads"—is indeed a broad one. There are many ways in which this Association and its members can be helpful. I will, however, mention what, in my opinion, is the most important thing, that is—qualifying ourselves to serve more efficiently, and I know of no better way of accomplishing this than to affiliate ourselves with an organization of this kind, where we are privileged to attend these conventions; take an active part in the meetings where problems of interest to the mechanical department of our railroads and to ourselves are discussed; and, where we are afforded an opportunity of mingling with men who are holding positions similar to our own. I am sure you will find men here who have successfully solved problems that are giving you much concern. Look them up; you may be able to help them, as they help you in solving the problems that are bothering you. Do not hesitate to use the floor of the convention, remembering that we are all representatives of the same department and our problems are pretty much the same.

The primary business of the railroads is to serve the public both safely and efficiently. Secondly, it is to sell transportation and, as in any other business, the difference between the actual cost of production and the price at which we can sell what we produce should enable us to pay taxes and other incidental expenses not included in the actual production cost and also afford a fair return on the money invested. The selling price of transportation, as furnished by the railroads, is more or less fixed. Therefore, it is perfectly obvious that if we are

to meet competition and increase our earning power, we must, as far as is possible, reduce our cost of production by increasing our efficiency.

The average cost of maintaining the equipment on the Class I railroads is, approximately, 19.2 cents of each dollar earned. I am of the opinion that this ratio can best be reduced and the efficiency of the service improved by properly maintaining the equipment. Poorly maintained locomotives and cars result in interruptions to service due to locomotive failures, derailments, accidents, etc. Such interruptions are not only costly from an operating standpoint, but result in complaints from the public as to the service rendered and, in a great many instances, loss of business.

I realize that in recent years the earnings of a great many of our railroads have been such that it has been necessary to reduce expenses to the point where they have not been able to spend the money on equipment that they would have liked to spend, and it is in times like these that we, as supervisors, should find ways and means of spending to the greatest possible advantage, the money allocated to us for maintaining the equipment. This can only be accomplished by men who are thoroughly familiar with the requirements of the service, the equipment to be maintained, and the job of maintaining it. Due to increased trend in the cost of new equipment and materials, it is, no doubt, going to be necessary to maintain what we now have to an extent greater than heretofore.

Planned Work Keeps Costs Down

One of the best ways I know to keep down the cost of maintenance and, at the same time, maintain the equipment in reasonably good shape is to properly program and schedule the repair work. The repair program should be based strictly on the requirements of the service. In the case of locomotives, this requires a thorough knowledge of the condition of the power and of the motive power requirements on the various parts of the railroad involved, together with a forecast of the probable amount of traffic to be handled during the period for which the program is being set up. With information on these three points at hand, it is possible to determine the approximate number of locomotives which will require repairs and the kind of repairs which will have to be made.

When this has been done, the schedule can then be prepared. It may take various forms but should show, for each shop, the locomotives to be repaired, the class of repair to be made in each case, and the date each locomotive is to be taken into the shop, and the date it is to be outshopped. Mileage records for individual locomotives are very helpful in setting up a repair schedule and allow the number of locomotives which will require repairs to be predicted with considerable accuracy. However, the actual shopping of each locomotive should be based on its physical condition as determined by inspection. I. C. C. requirements, such as the removal of flues, the testing of flexible staybolts and caps, etc., will have considerable influence in determining an efficient shop schedule. Locomotives should be scheduled for general repairs, as far as is possible, at times when these tests and inspections become due.

Repair programs and schedules should be set up as far in advance as is reasonably possible; however, they should be revised currently to take care of changing conditions. These include fluctuations in the amount of business to be handled, accidental damage to locomotives and equipment, changes in the condition of the power and equipment as determined by more recent inspections, shortage of labor or material, etc. It may not always be possible to follow an original schedule in every detail; however, the total amount of work to be done during the time involved can usually be determined with a fair degree of accuracy. This is the principal advantage in programming and scheduling our repair work.

If we determine the total amount of work required to maintain the equipment in condition to handle the business, we are then in a position to arrange to do this work in the most economical manner. We know the amount of material and labor required and can, therefore, estimate the cost. We can also organize our shop forces to perform the work with a minimum number of men and can order the necessary material so as to maintain minimum stock inventories. All of this tends to improve efficiency and reduce maintenance cost.

Modern Facilities Help Reduce Costs

Another important factor in the economical maintenance of equipment is adequate and well maintained shop facilities and machine tools. It is not always possible, for financial or other reasons, to obtain the machine tools which we would like to have. However, considerable good can often be accomplished by careful study of existing shop layouts and rearrangement of existing facilities to reduce lost motion and promote a smooth flow of work through the shop, also by improving the condition of existing machine tools, which can frequently be done at comparatively little expense. When new machine tools are purchased, it is generally good practice to place them at the main shops where production is greatest and to move the older machines to smaller outlying points where they are adequate to handle the work required. In this way, it is possible to get the maximum advantage from the new machines.

There is one point in connection with economical maintenance of equipment which is not always given the attention it should have. This is the reclamation of material. The cost of new material is now increasing, therefore, the reclamation of used material is becoming more important and a considerable amount of money can be saved or lost in the scrap pile. The reclamation of material should be under the direction of an organization responsible for this work alone. Such an organization need not be large except on railroads where the quantity of material handled is sufficient to justify the operation of a centralized scrap-handling and reclamation plant. In many cases, one properly qualified man will suffice. He should pay frequent visits to the points where scrap is made to see that material suitable for further use and material which may be repaired and reused is reclaimed and not allowed to get away in the scrap. Success in this depends on the cooperation of all concerned and it is a duty of the locomotive maintenance officer to see that this cooperation is obtained.

I mentioned briefly the rules and regulations of the I. C. C. Bureau of Locomotive Inspection covering the inspection and testing of locomotives and their effect on the shopping program. These rules and regulations, being law, must, of course, be obeyed implicitly and the locomotive maintenance officer should be thoroughly familiar with them. However, aside from the penalty involved in failure to comply, it is to his advantage to see that they are lived up to because they tend to promote safety and the reliability of the motive power, thereby reducing engine failures and road delays. It is my belief that they also tend to reduce the cost of locomotive repairs in the long run, since they require a higher standard of maintenance than might obtain in some cases if they did not exist.

I am sure you have found that the personnel of this Bureau has, as well as that of the Bureau of Safety, administered the rules and regulations in such a manner as to promote cooperation between the railroads and

themselves, and have been a great aid to locomotive maintenance officers in properly maintaining the equipment. It has been my experience that those who make a conscientious effort to maintain their equipment in safe and suitable condition for service will receive most hearty cooperation from these Bureaus.

As I mentioned in the beginning, the subject assigned to me for this discussion is a broad one and I have mentioned only a few of the points involved. This being a locomotive maintenance organization, I have confined my remarks principally to locomotives; however, they apply equally well to the maintenance of freight and passenger cars. It all leads up to the fact that the first duty of a locomotive maintenance officer is to do the best he can with what he has in the way of equipment, facilities and personnel. In order to accomplish this with the maximum benefit to his company, he must qualify himself thoroughly for his job. This can only be done by continual study of the problems involved, by keeping up with the latest developments in the field and by familiarizing himself with the latest information available. I know of no better way to accomplish this than by affiliation with an organization such as yours and taking part in its activities. I repeat that, in my opinion, the members of the Locomotive Maintenance Officers' Association can do more to improve service on all railroads by promoting the free interchange of ideas among its members than by other means.

Discussion

In the discussion of Mr. Hitch's paper one of the most important things mentioned was the value of stabilized operations. In reply to several questions the speaker told of the work that had been done on the C. & O. to plan all maintenance operations three and six months in advance so that the management could provide the necessary appropriations to assure that the program of work was carried along on a stabilized basis; so that material could be ordered from manufacturers far enough in advance to assure positive delivery at the time when it was needed. Mr. Hitch made the suggestion that carefully planned and stabilized operations were one of the most important factors in controlling the costs of maintenance.

Use of Machinery and Tools In Locomotive Repairs

By D. J. Sheehan

Superintendent Motive Power, Chicago & Eastern Illinois

The 1940 annual meeting of the Locomotive Maintenance Officers' Association is being held at a time when the entire world is in a chaotic condition. Our country is faced with a grave situation politically, economically, diplomatically and industrially. The transportation industry, and particularly the railroad industry, will again play a very important part in the industrial crisis in this country as well as in the military crisis, which it seems will soon be upon us.

We, who are identified with this Association, will play a very important part in the success of railroad operation which must be greatly accelerated to meet emergency demands. We must be prepared to put locomotives in service that will remain in service for the longest possible time. We must be prepared to maintain the condition of locomotives now in service in the shortest possible time. In order to do this, we must take advantage of every opportunity to do our particular work more efficiently, more economically and with utmost dispatch.

The locomotive maintenance officer has at his command three definite and essential organization components from which to secure successful and efficient maintenance. The first of these is a staff of well trained and efficient supervisors. A great deal has been said in past papers presented before this association on that very essential element for the successful operation of a locomotive shop. Thus, it may be assumed that we are all aware of the importance of providing and maintaining well trained and efficient supervisors.

The second is a corps of highly trained and efficient workmen. We have repeatedly heard in recent months that there is an acute shortage of trained and skilled manpower available for industry. Those of you who may have had recent occasion to augment your forces are well aware of this fact. The railroads will not be able to increase the manpower to expedite repairs to locomotives and to rolling stock without skilled men. Consequently, if we are to speed up maintenance programs so that we can maintain motive power in an efficient and economical manner and with the utmost dispatch, we must turn elsewhere for the solution to the problem.

The third and only remaining component is the efficient and economical use of machinery and tools.

Many locomotive shops are equipped with tools and machinery that are not modern. Some of this equipment, particularly the machines, has been permitted to lapse into a poor state of maintenance. Many machine tools in service today would cause the question to be raised as to whether or not the work obtained from them after an extensive overhauling would justify the cost of the overhauling. In some cases, it will be found that for very modest expenditures machine tools now in service can be put into condition to perform continued efficient and economic service. In other cases it will be found that after an intensive study and analysis a greater advantage would be derived by replacing these machines with new and more modern units.

In the case of those machines which are in a good state of repair and capable of performing a satisfactory job economically and efficiently, special studies should be made to develop the use of quick-change jigs and fixtures. The use of some of these ingenious devices will result in great advantage.

Under present conditions if it is decided to replace present machinery with new and more modern machinery it will not be possible to secure the new and modern machinery for a considerable period of time. Thus, it will be necessary to put the old equipment in the best possible conditions to do the job while waiting for the arrival of new equipment.

There are available a great many improved machine tools and other repair shop facilities which, if used to replace obsolete and inefficient equipment would greatly assist in producing results which are absolutely necessary to meet demands that are being placed on motive power.

The final approval for the selection of a machine or tool to replace obsolete equipment rests with the ranking mechanical officer. Too often such selection has been based only on the personal opinion of an individual who is a member of the mechanical staff.

The question of whether a planer should be replaced by a more modern planer, or an improved machine of the planer type, or a milling machine, can only be determined by a most careful analysis of all the factors involved in equipment replacement and experience and judgment must be augmented by thorough studies of the work to be performed by a new machine.

It is possible for a piece of modern machinery to be absolutely essential, highly efficient, and very economical. At the same time this same piece of machinery may be absolutely unessential, highly inefficient and very uneconomical. Again, this same piece of machinery may have neither of these qualities—it may be purely ornamental.

If you were to purchase and place in your shop the most modern machine tool and place it in a glass case, it certainly would be neither absolutely essential nor absolutely unessential, it would be neither highly efficient nor highly inefficient, it would be neither very economical nor very uneconomical. It would merely be an ornament. On the other hand, if this same piece of modern machinery were purchased and put in your shop without careful study, planning and supervision, it might be absolutely unessential, highly inefficient and very uneconomical.

It would be possible to put a piece of modern machinery into a shop to do a wide variety of work requiring a great many changes in setting up and a consequent loss of time. It can be appreciated that such an installation might prove unessential, inefficient and very uneconomical.

Job Analysis Will Show the Way

However, if in the selection of a new machine to replace an obsolete one, a careful analysis of the work to be done on the new machine is made the desired results can easily be obtained.

It is often possible to find a new machine which will decrease the floor-to-floor time on a machine operation as much as 50 per cent. This fact alone does not necessarily justify the installation of new machinery. It may be found that this particular machine, with an apparent saving per unit of work can only be utilized a small portion of the working time. If modern machinery is put into a shop, it is of prime importance that it be kept busy. A machine that does an economical job one hour a day and an uneconomical job one hour a day and an uneconomical job 23 hours a day, does not contribute to any real saving nor is there any justification for its purchase.

"It is well to keep in mind that a unit of shop equipment, like a locomotive, can only justify its existence if it is kept busy. Therefore, it is obvious that if a special-purpose machine, designed to do one job and one only, is installed in a small shop with a limited volume of work it will probably prove to be an unsound investment whereas the same machine installed in a specialized department of a large shop may effect such savings as to pay for itself in two or three years.

"This is a good time to call attention to the fact that machine performance studies will often indicate that the actual machining time on locomotive parts may represent but a small part of an eight-hour day. The rest of the time is often consumed in setting up work on the machine and in handling the parts to and from the machine. In this, there is an important lesson for all of you who have the responsibility for selecting shop equipment. If adequate handling facilities are not provided for each machine, and if the proper jigs and fixtures are not available, it is quite probable that the greater part of the potential productive capacity and economy of a machine tool unit will be dissipated. Here again is the proof of the necessity for careful study and planning on the part of the officer in charge of a shop.

Many modern machines can be designed so that the work table will hold two or more sets of fixtures for holding various types of work. I am thinking particularly of some of the larger type millers which may be equipped, more or less permanently, with fixtures for holding crosshead shoes, shoes and wedges and driving boxes. When work of one class is being done, the fixture for the other class of work can remain on the work table, but located away from the milling cutters."

How to Get New Equipment

It is not uncommon to hear a locomotive maintenance officer make a statement to the effect that a new machine of a certain type would save a lot of money for his railroad if the machine were installed in his shop, but that the company does not have the money to purchase such a machine. This statement is usually made without proper thought and consideration. Railroad managements are always on the alert to replace tools and equipment that will result in a net saving. If the installation of a new machine will actually result in a net saving and, if the officer who recommends the installation makes a careful analysis of the potential savings he should have no difficulty in selling the idea to his management.

One of the greatest difficulties that a locomotive maintenance officer has in selling his management with the idea of a new installation is that he himself does not thoroughly analyze costs and conditions with existing machinery and tools and develop a sound comparison of the savings possible by the installation of more modern types of machinery. If he cannot conscientiously satisfy himself that there are very definite savings to be made, he should never attempt to convince his management that there may be some savings in new installations.

Too often the statement is made that if certain new machinery or tools were purchased more work could be produced in the shop, but when an analysis is made there is no normal need to increase output.

I believe there is another matter coming under the general heading of the use of modern machinery and tools which is often overlooked. In years gone by we sometimes felt that if we supplied our mechanics with tools they should be able to do the work properly. Many of the older type tools, particularly tools such as air motors, chipping hammers, riveting hammers and portable grinders were very heavy and awkward to handle. Many of us have overlooked the fact that the continual use of these heavy and awkward tools resulted in fatigue to the workman so that his efficiency and the ability to perform his work satisfactorily was greatly reduced as the work day wore on.

Modern developments in tools of this general character have produced efficient, lightweight, convenient tools and handling devices which will greatly assist in conserving the workman's energy for a greater number of hours.

In recent years a great deal of thought has been given to the development of so-called gadgets in railroad shops. In visiting various shops, it is not uncommon to see tools hanging from various types of supports, many being supported on spring balances. Practically no physical effort is required to put the tool into working position.

In one shop I recently observed a so-called gadget on which was suspended two large air hammers. By means of hand wheels and foot pedal throttles these air hammers were moved together and used very efficiently for double gunning rivets in a two-piece spider and bull ring. With this simple device, fatigue is practically eliminated from normally heavy jobs. Not all these so-called gadgets are home made. Many of them are avail-

able at low cost—a cost so low that it is not hard to justify their purchase and installation.

In closing, I want to say that, "in my opinion, there has never been a time in the history of American railroads when it is more important for officers and supervisors who are responsible for locomotive maintenance to study every job and the equipment with which the job is performed with the idea of determining whether or not obsolete facilities are depriving us of the output we need at a price we can afford to pay. As the volume of railroad traffic increases and the demand for motive power becomes more pressing, we are going to be up against a real problem to keep maintenance costs from getting out of line. Careful planning and the development of an intelligent program for the replacement of obsolete equipment offer the most logical solution of the problem of controlling costs."

Discussion

It was evident, from the remarks of several members, that shop officers and supervisors have considerable difficulty in getting the new equipment they need to replace old facilities. Mr. Sheehan took occasion to reiterate his remarks to the effect that the reason such difficulty is often encountered is that shop and enginehouse supervisors do not make a sufficiently thorough study of the problem at hand to build up a good case for the facilities they are trying to get. Management, he said, is always alert to the possibility of saving expense but that it is up to department heads to prove beyond any doubt that the facilities they are asking for will result in definite economies. Only by making a complete analysis of specific conditions can one decide whether or not a new tool should be purchased and he concluded with the statement that "if you can prove you need it, you can get it."

The Design, Operation and Maintenance of Diesel-Electric Locomotives

By H. V. Gill

Supervisor Diesel Engines, Atchison, Topeka & Santa Fe

The application of Diesel engines as the prime mover using an electric transmission for propulsion of locomotives on railroads of the United States has been used for a great many years. However, the intensified development of this type locomotive dates back only five and a half years to 1934. In that year the engineers of the Santa Fe and Electro-Motive Corporation collaborated on the design of a Diesel-electric locomotive capable of handling 14 cars on one per cent grades, and in November, 1935, the locomotive was delivered. The locomotive was powered with four 900 hp., 12-cylinder, V-type, two-cycle Diesel engines furnishing power for traction, and two 90 hp. four-cycle Diesel engines for auxiliary power.

Many difficulties were experienced with this locomotive such as camshaft breakage, crankshaft bearing failures, traction motor and generator failures, short wheel life, piston failures and cylinder heads cracking. These conditions have all been improved by the strengthening of the design and the application of more efficient air filters, oil filters and radiators.

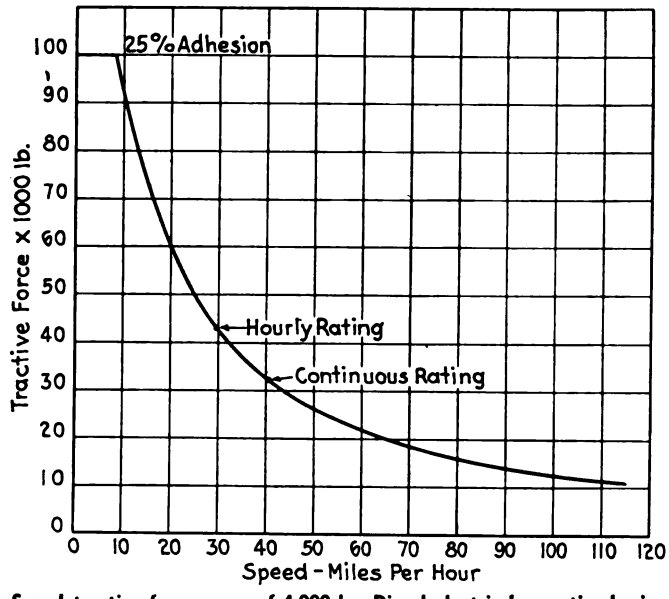
Also, in February, 1935, a 600 hp. Diesel-electric switching locomotive was placed in service. Since then an additional 40 switching locomotives and 17 high-speed road passenger units have been placed in service, making a total of 73,140 hp.

The high-speed road passenger locomotive units are all powered with two 12-cylinder, V-type, two-cycle Diesel engines per unit. The maximum speed is 117 m. p. h. The Diesel units have accumulated 7,684,111 miles of service to June 1, 1940, with an availability of 95.3 per cent.

Switching locomotives are powered with either the four-cycle or two-cycle Diesel engine and are at present time protecting 121 eight-hour switch tricks per day. They had an availability of 94.3 per cent during 1939.

The electric transmission is an important and expensive part of the equipment and at the present time is the major limiting factor in so far as continuous operation on heavy grades is concerned. This is due to the necessity of dissipating the thermal losses from the traction motors and generators. In selecting or assigning Diesel-electric locomotives for service, the thermal capacity of the electric transmission must be carefully considered to make sure that it is sufficient for the duty cycle.

Another limiting factor which interferes with continuous operation of the Diesel-electric locomotive on heavy grades during extremely hot weather is the dissipation of the tremendous amount of heat generated by the Diesel engines, and this is one of the most important problems encountered when designing Diesel locomotives. The difficulty is brought about by: Space limitations;



Speed-tractive force curve of 4,000 hp. Diesel-electric locomotive having two body units, each with two 1,000-hp. Diesel engines, two generators and four traction motors—36-in. truck wheels and 52:25 gear ratio

[Note: Mr. Gill presented a paper on this subject before the Society of Automotive Engineers at Los Angeles, Cal., February 9, 1940, a considerable portion of which was used in the paper presented at this meeting. The previous paper was published in the *Railway Mechanical Engineer*, April, 1940, page 131 and the reader is referred to that paper for additional details not included in this abstract. The inspection and repair forms, and maintenance record form, Nos. 1226-DS and 1226 D will be found on pages 133, 134 and 135 of that issue.—EDITOR]

weight per axle limitations; and, horsepower required to drive cooling apparatus.

In maintaining and operating Diesel locomotives, one of the major problems confronting all railroads was to train personnel to handle and maintain this type of power. New facilities, tools, etc., were required. That the railroads have met this problem is evidenced by the performance of the locomotives.

Maintenance Methods and Facilities

At Chicago, the Santa Fe has built a shop especially designed for handling Diesel locomotive repairs. With these new facilities, repairs should be expedited, resulting in greater availability for service and reduction in maintenance costs.

Special maintenance and inspection schedules in addition to the I. C. C. requirements have been found necessary to secure reliable economical service from the locomotives. These requirements are met by the schedule shown on Form 1226-DS, Santa Fe Standard, for Diesel-electric switch locomotives. This schedule is based on monthly service.

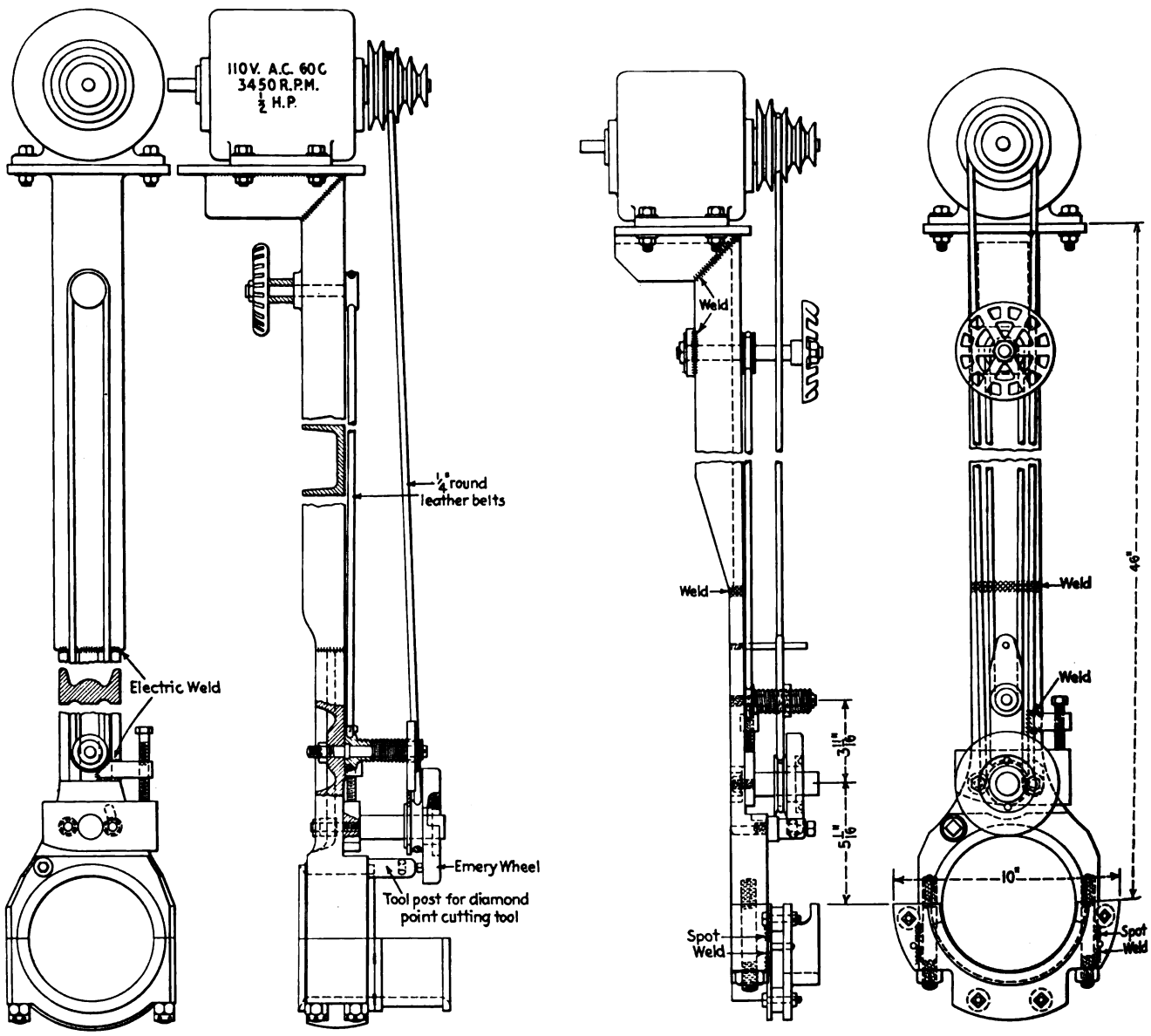
For road service, the schedule outlined on Form 1226-D*, Santa Fe Standard, is followed. Maintenance and inspections for road service are handled on a mileage basis. A copy of Form 1226-D is carried on each respective locomotive unit; therefore, the record of maintenance and inspection is always available to maintenance forces over the system.

A special instruction bulletin has been issued to cover in detail just what attention each item on Forms 1226-D and 1226-DS requires.*

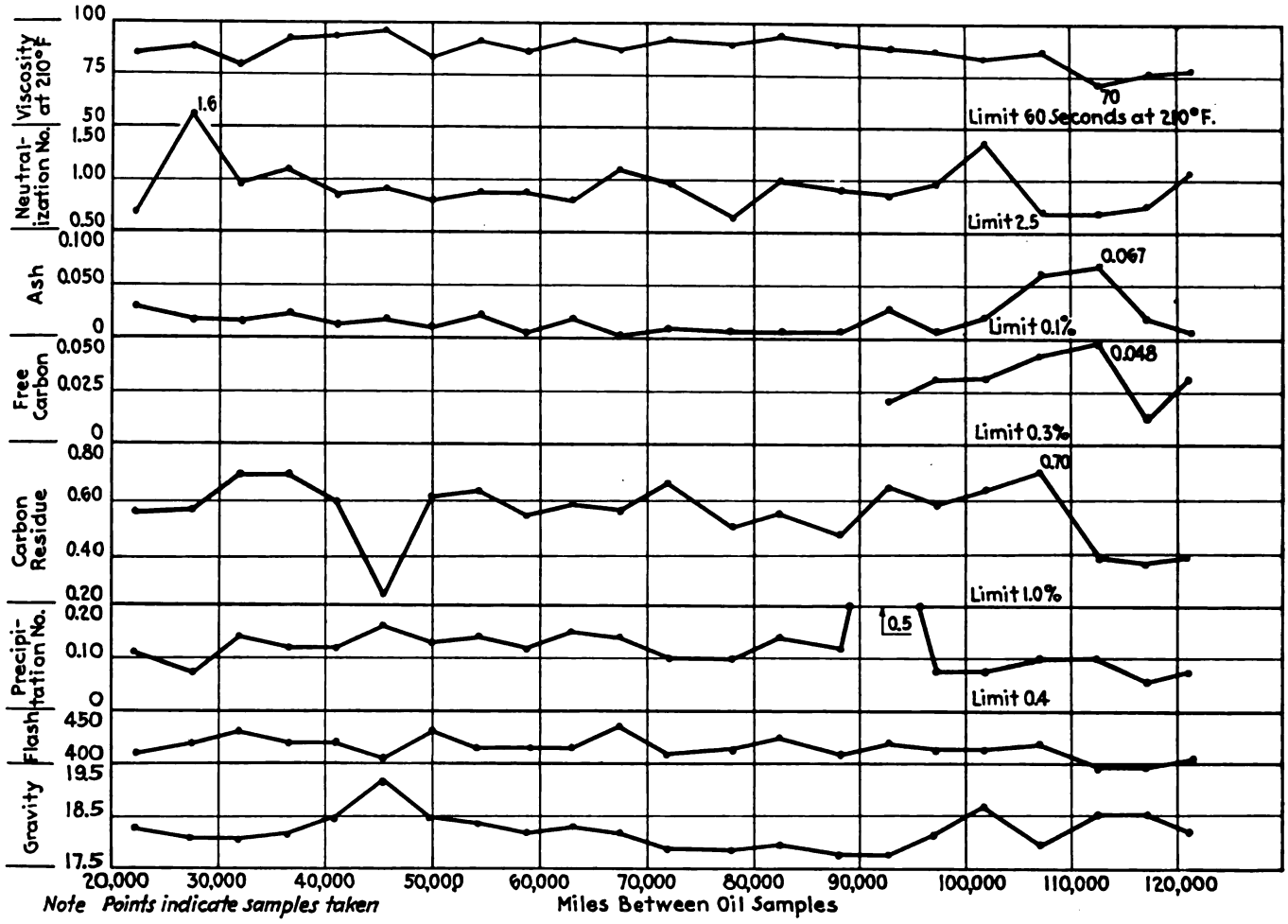
In road service a Diesel maintainer always rides the locomotive while it is in service. These maintainers are organized on a system basis. They make a complete log report of each trip, report to maintenance terminals all repairs and inspections required, and inspect their locomotives sufficiently in advance of departure from terminal to insure that necessary repairs have been properly performed.

A specially trained man has been assigned to follow the disposition of materials and he also keeps mileage records of locomotive performance and records of service

* Portions of the bulletin were published in the May and October, 1940, issues of *Railway Mechanical Engineer*. The forms mentioned appeared in the April, 1940, issue.



Two types of crankshaft, crank throw grinding machines designed and built by the Santa Fe. The type at the left is for grinding the pins on V-type Diesel engines where two connecting rods are side by side on the same throw; the machine at the right is for all types of Diesel engines which have only one connecting rod on each crank throw



Lubricating oil analysis chart showing condition of crankcase oil over 120,000 miles of service without oil change

received from cylinder heads, cylinder liners, pistons, traction motors, axles, wheels and other parts that are subject to frequent inspections or renewals.

Another specially trained Diesel man is assigned to follow switch locomotives over the system. He inspects the locomotives, checks the operation and instructs maintenance forces and operating crews in proper Santa Fe practices.

Lubrication and Mechanical Changes

Lubrication has played an important part in the operation of Diesel engines. By the use of effective oil filters the lubricating-oil drain periods in high-speed passenger service have been increased from 5,000 miles to 100,000 miles of service. In switchers, crankcase lubricating oil is changed every three to six months of service. The lubricating oil analysis chart shows the condition of crankcase lubricating oil covering 120,000 miles of service without changing oil.

It has been found desirable to conduct service tests in addition to laboratory tests before deciding upon the acceptability of fuel and lubricating oil.

All of the present road locomotives are powered with two-cycle Diesel engines. Since these locomotives are operated under a load factor of about 60 per cent, more trouble is experienced with the Diesel engines. In fact the Diesel-engine maintenance expense comprises about 50 per cent of the total locomotive-repair costs. Therefore, the two-cycle Diesel engine used in this service has been given a great deal of thought resulting in many improvements.

Pistons and cylinder heads are removed every 100,000 miles for inspection and servicing. Crankshaft bearings

Table I—Average Cost of Operation Per Service Hour for 1,000 HP Switch Locomotives—Year 1939

	1,000 hp., 4-cycle Diesel-elec. loco.	1,000 hp., 2-cycle Diesel-elec. loco.
Fuel	$0.282	$0.261
Locomotive repairs, labor and materials	0.119	0.336
Estimated cost general repairs	0.250	0.250
Enginehouse expense	0.026	0.028
Lubrication	0.022	0.045
Supplies	0.021	0.014
Total cost per service hour	$0.720	$0.934

Note—Figures do not include depreciation or wages of enginemen.

are inspected at this time and interior of engine thoroughly cleaned out.

Cylinder liners that were worn 50 to 60 thousandths

Table II—Cost of Operation per Mile—High-speed Passenger Service 4,000 HP—Year 1939

Fuel	$0.123
Locomotive repairs, labor and material	0.137
Lubrication	0.011
Supplies	0.007
Water	....
Total cost per mile	$0.278

Note—Figures do not include wages of enginemen or depreciation.

of an inch in about 60,000 miles are now removed when worn 20 thousandths of an inch after 325,000 miles of service and are re-conditioned for re-application.

Piston design has improved. At the present time, the drop-forged aluminum piston with greatly increased ring land width is giving the most dependable service. Piston

assemblies are removed for inspection every 100,000 miles and the service mileage received from pistons removed from road locomotives to date is 220,000 miles. This mileage feature will be greatly increased as new type pistons replace the older design.

Air for engine radiators is now carried through ducts eliminating dirt from this source getting in the engine rooms.

Wheels have been greatly improved. The service life of present wheels is about 250,000 miles with about 84,000 miles between machinings.

A crankshaft crank-throw grinding machine, designed and built on the Santa Fe, is now used at important terminals. By using this machine, we expect to run 1½ million miles in road service before removing crankshafts from the Diesel engines.

The Electro-Motive Corporation has built a 5,400 hp. freight locomotive powered with four 1,350 hp. Diesel engines. It has a starting tractive force of over 200,000 lb. and a maximum speed of 73 m. p. h. Extensive tests of this locomotive were very satisfactory, and two of these locomotives have been ordered. Two 44-ton switchers have also been ordered.

Discussion

In discussing the maintenance of Diesel locomotives one member from an eastern road raised a question as to the cause of the cracking of cylinder heads, mentioning the fact that on one recent trip six out of twelve heads on one engine were found to be cracked. Mr. Gill replied that when such a condition was found it could usually be traced to defective cooling and suggested that the engine cooling system be thoroughly checked for air locking, or binding, in some part of the cooling system.

Another member raised the question of comparative maintenance costs between Diesel and steam power. The speaker called attention to the fact that when costs are compared they must be compared on specific cases and conditions and said that a recent check of comparative costs between a steam passenger locomotive of 4,464 hp. and a Diesel of 4,000 hp., over a 30-day period, showed a cost of 19 cents a locomotive-mile for steam and 17 cents for Diesel. As to engine failures, it was brought out that on one road the average mileage between engine failures was 74,000 for steam and 144,000 for Diesels.

Future Locomotive Air-Brake Maintenance

By J. P. Stewart

General supervisor air brakes, Missouri Pacific

Train operation requirements have been and are constantly growing in magnitude and complexity. Faster schedules, higher speeds, longer trains, heavier tonnage per train, greater tonnage per car, new designs in motive power, high speed, light-weight trains, all are constantly calling for new appliances and improvements in existing standards.

As changes have been made in equipment, the application of new and special appliances have increased the responsibilities of the supervisor of locomotive equipment.

To meet this progress in transportation has not only increased the responsibility of supervision, but has brought about a change in the system of maintaining the equipment. Today, more than ever, it must always be first in mind to find the small, or the beginning of, defects. The elimination of a small defect is often the eventual elimination of an engine failure and a saving in man hours and expense. It is a big mistake to put off the elimination of a small defect until next trip because it is constantly becoming a major defect, and what today is a minor defect, if allowed to continue, will tomorrow be a major defect and perhaps an engine failure. Therefore, I wish to register with each of you that in the most perfect operating equipment, it is the elimination of the small defect that gives the efficient operation and keeps the cost of maintenance low. With the increased demands for speed put on the locomotive today, the locomotive must leave the terminal absolutely free of defects, either major or minor.

In this paper I am constantly bearing in mind the proper procedure to follow to bring about the results necessary for perfect train operation.

I know it is often difficult for the old timer to adopt new systems. There was a time when the air-brake inspector or air brake machinist was considered a specialist, and the real profession of the operation of the air-brake equipment was surrounded with a veil of mystery, and, when the apprentice started serving his time he was sworn never to reveal any of the arts of his profession unless it was to a bonafide student who was also serving his time. Today we are endeavoring to make all familiar not only with the maintenance and operation but with all the effects of the equipment and the manner in which to continue the operation regardless of defects.

Exit the Specialist

In my opinion, the day of the air-brake man as a specialist is coming to a close. To stay up in the ranks of up-to-date supervisors, a man has to be familiar with the operation and maintenance details of many different appliances and types of equipment. This is made possible by the manufacturers, associations, sales organizations and service engineers and by high class literature which makes it possible for any man to master any part of the equipment or any special appliance. Do not misunderstand me, that I am trying to advance the idea that all men working in the shop or roundhouse should be expert air-brake man, but the thought I wish to convey is that any man who so desires can, by applying a little time and study, familiarize himself with the operation and maintenance of all parts of the locomotive equipment, or any of the special devices, so that he will actually have a wider knowledge and a better understanding of the device or appliance than did the so-called expert of yesterday. Furthermore, it will not cost this seeker of information one penny for text books or lessons, but just for a few three-cent stamps he will have delivered right to his door, books, pamphlets, and literature furnished free by the manufacturers, which a few years ago could not be purchased at any price. Furthermore, the veil of mystery has been removed from the process of assembly and manufacturing so that today anyone who desires may visit any of the large manufacturing or processing plants, where he will be taken on an educational tour of instruction and inspection.

I wish to pay the greatest tribute to the locomotive manufacturers, and, when I say locomotive, I include all companies that manufacture special appliances for loco-

motives, for the educational advantages and the efforts they are putting forth to educate the railroad employes in the operation and maintenance of their equipment.

Not so long ago I had a forceful example of this. On two divisions we had large freight locomotives equipped with a special appliance with which most of you men are familiar. About every other day on the morning delay report there would appear a delay of 10, 15 or 20 minutes because of the failure of this appliance. We sent the air-brake instruction car to that territory and, as attendance for enginemen is compulsory, every engineman attended the car and received his card of attendance. In spite of all that the master mechanic, general foreman, road foreman of engines, my assistant or myself could do, these little annoying delays would show up. They were not real engine failures or appliance failures; they were man failures, so we asked the appliance company for several hundred instruction books. These books were gladly furnished and we gave one to each engineer and fireman. The result was that in two weeks, as far as the delays were concerned, you would not know we had such an appliance on our locomotives.

For our railroad to have printed such instruction books would have cost at least 50 cents per book, the compilation of the information would have cost considerably more, and as the distribution ran into hundreds, this educational drive would have been prohibitive without the entire cooperation and support of the manufacturing company. Therefore, I trust you appreciate the educational facilities we have gratis, and, by taking advantage of it, will greatly assist in reducing maintenance costs and also reduce the number of delays.

With the facilities of education we now have, let us now get to the real meat of this paper and see how we can get the best maintenance of the air-brake equipment at the most economical cost. I want to warn you that I will be unable to hold my thoughts directly on air-brake equipment alone. As we proceed, you will see that the methods of maintenance I outline will include air-brake equipment, as well as other important appliances.

Today the duties of locomotive maintenance supervisors, such as shop superintendents, master mechanics and general foremen, are so manifold that it is absolutely impossible for them to be in direct touch with most of the maintenance. Consider for a minute the time consumed in attending meetings, such as craft committee meetings, safety meetings, budget meetings, booster meetings, charity drives, etc. For this reason, he must have working under him men who are not only loyal to his interests but who know their jobs and have the ability to function without personal supervision. Therefore, I am going to build up a shop organization designed to get the best maintenance at the most economical rate for the back shop.

The Ideal Shop Organization

First, all special appliances should be together in one department or unit. By that I mean air-brake equipment, boosters, stokers, feedwater heaters, exhaust-steam injectors, injectors, force-feed and hydrostatic lubricators, reverse gears, gauges, air fire doors, bell ringers, and steam-heat equipment. Over these I am going to place a foreman, a monthly rated man. The general foreman is going to give this man absolute authority over the repairing and testing of this equipment. When a locomotive comes into the shop, this foreman will see that this class of equipment is removed, overhauled, tested and made ready for replacement on the locomotive.

The cost of overhauling is up to this man, and he alone can sign requisitions for new material. The only parts of the equipment he does not have the authority to supervise is the electrical equipment which coordinates with the air-brake equipment on some of the high-speed brake schedules. This equipment is sent by him after removal to the electric shop and, after being repaired, it is sent back to the special-appliance shop. It is up to the judgment of this foreman as to the amount of work necessary on the appliances; also, this foreman must be familiar with the operation and maintenance of the different appliances. He must be the direct representative of the general foreman, and, as the shop superintendent holds his general foreman responsible, so, in turn, the general foreman holds his foreman of appliance maintenance responsible, just as he holds his boiler foreman, machine foreman, blacksmith or pipe foreman responsible.

You will be surprised to see how the maintenance of the different appliances is naturally associated. As an illustration, the air-pump mechanic, with very little training, becomes an efficient feed-water-pump mechanic; the stoker mechanic grasps the maintenance of boosters; the fire doors, reverse gears and bell ringers group themselves together; while the gages, force-feed lubricator and speed indicator appear to come under the handling of one mechanic; and the feed valve, brake valve and distributing valve will come under the same mechanic. Thus, as these men become familiar with the same classes of equipment, they become more efficient.

On the railroad I represent, we have two main shops in which we have this system. In order to distinguish these men, they are given the title of air-brake foremen, which they still carry, but, in reality, they are foremen of special-appliance maintenance. Both of these foremen are students picked from the ranks because they were first-class mechanics, loyal to their superiors, pleasant to work with and below middle age.

The Enginehouse Supervisor's Problem

The master mechanics and general foremen of the engine houses are up against a different proposition. Theirs is altogether a different line of operation than the back-shop supervisors. For the master mechanic and enginehouse foreman the whistle never blows; it does not blow to stop work, therefore, it cannot blow for them to start. It is not an eight-hour shop; their telephone is always ringing. Their one duty is to furnish engines when the despatcher needs them regardless of the amount of work necessary to be done on the engine. It must be ready when needed.

Each enginehouse foreman should have two good men in the positions of lead airman and engine director. In picking these two men, we should consider, first—that they should be young enough so that it is easy for them to study and learn and thus keep pace with the advance progress of new appliances and equipment, and second—that they should have sufficient seniority so they will not be displaced everytime there is a force reduction. It is very discouraging to go to a point and find a man inspecting engines who does not know the names of the different pipes on the distributing valves.

We might classify these two positions as the "finder" and the "fixer." To them the foreman looks for the analysis of the condition of the locomotive. Usually it is to the engine inspector's, or the "finder's" report that he looks before he tells the dispatcher how soon he can have the engine.

Now we are going to make a "finder" out of our engine inspector. In addition to just inspecting the engine for I. C. C. defects, we are going to make an air-brake test man of him.

Locomotive Equipment Has Changed

A few years ago, the locomotive air-brake equipment consisted of a 9½-in. pump, reservoir, brake cylinder, feed valve and brake rigging, G-6 brake valve and a Du-

plex air gage. At that time we had to have a special air-brake man to test out that brake equipment. I find in many places that we still cling to that system. Today we have large power, compound pumps, special appliances, H-6 and H-8 brake schedule, or HSC electro-pneumatic brake or HSC automatic brake schedule, but, in spite of all these increases, I say we should not have to have a specialist to test the air-brake equipment. This does not seem consistent, following a comparison of the present and past equipment. With the increased parts of the present equipment, I feel that, with the educational advantages I have so fully previously described and the superior quality of the present-day equipment, both in precision of construction and operation, the superior materials now used with the adoption of the composition gaskets and seats, more detail and greater attention to engineering and tests before being approved for service, there is no need for so much specialization in special appliances and air-brake equipment, as in the past. At the roundhouse, keep the air-brake mechanic as a fixer and use the engine inspector as a finder. That does not mean that the air-brake mechanic should not test out the equipment. Whenever any work is done on any appliance, he should test it out before he pronounces it OK. But to let the engine come in and not get the air-brake equipment tested until the air-brake mechanic gets to it, may result in unanticipated delay.

Now let's see how this works. In the first place, I believe strongly in inbound inspection and test. This gives the foreman assistance in distributing his force. Information developed in this manner, in addition to that shown on the engineman's or road foreman's work reports, enables the foreman to know what work has to be done on the engine and how long before the engine can be reported ready for service. So, as soon as possible after engine arrives on the incoming lead, the inspector will start his inspection and, as he looks for I. C. C. defects, he will also inspect the brake equipment. The locomotive should be left with brakes applied so the inspector will get his brake piston travel. As he passes the main reservoir, he will open the bleed cock on the main reservoir, which will cause the air compressor to start working, and he will listen for pounds and blows. When he gets up in the cab and checks, he will make the following tests:

1—Release brakes, adjust feed valves to standard pressure and note variation of feed valve which must not exceed 2 lb. per min. At the same time note adjustment of low-pressure governor.

2—Make a 10-lb. brake-pipe reduction with the automatic brake valve. Note that preliminary exhaust port is open and equalizing piston raises. Place automatic brake valve on lap position. Note brake-pipe leakage which should not exceed 3 lb. per min. Note adjustment of high-pressure governor. Release brakes.

3—Apply brakes with independent brake valve in slow-application position with 5-lb. brake-cylinder pressure. Move brake valve to running position. Brakes should release.

4—Apply independent brake valve fully in quick-service position. Brake-cylinder gage will show adjustment of reducing valve. Spring should return handle of independent brake valve to slow-service position. Move automatic brake valve to full-service position. Note adjustment of safety valve on distributing valve. Release brakes.

5—With automatic brake valve make a 5-lb. brake-pipe reduction. Brakes should apply. Move automatic brake valve to running position. Brakes should release.

6—With automatic brake valve in running position, brake-pipe hand and equalizing-reservoir hand on large and small duplex gages should correspond. Move automatic brake valve to full release position. Warning port should blow and brake pipe and equalizing-gage hands should register within 3 lb. of main-reservoir hand. Move brake valve to running position.

7—Move automatic brake valve to emergency position. Brake should apply in emergency. Return brake valve to lap position and note no increase in brake pipe pressure. Also note that brake-cylinder pressure does not decrease.

These tests can be made in a very short time, and will prove that brakes are operating and all operations meet the I. C. C. requirements as set forth in Rule No. 106.

Should the inspector find the brakes do not meet these tests, he will at once give a report to the air-brake mechanic or lead man whose duty it is to find the defect and make necessary repairs.

I. C. C. requirements are that an orifice test be made on the air compressor once each three months. I will recommend that the air-brake mechanic make an orifice test on compressors once each 30 days. He should keep a running record of each orifice test. When the orifice test shows that the strokes are nearing the limit, he can arrange to apply new rings or change compressors on a trip most convenient, and he can spread out his heavy compressor work so as not to have this work coming due when he is busy on monthly or quarterly inspections. I strongly advocate the application of a copper tag to each compressor showing shop initials and date pump received last general overhauling. This gives the foreman and air-brake man a line on the quality of work coming out of the shop and length of service before receiving necessary repairs.

It is necessary that the air-brake mechanic make tests for brake-cylinder leakage at frequent intervals. Brake cylinders should be given a first-class cleaning at time of general overhauling of locomotive. At that time new composition packing cups should be applied. Then it will not be necessary to clean brake cylinders again until brake-cylinder leakage is such that locomotive or tender brakes will not remain applied five minutes with communication to brake cylinders closed.

This is worthy consideration, as on the large modern locomotive it is a lengthy and costly job to clean and lubricate the brake cylinders. I find that if the brake cylinders are properly conditioned, lubricated and equipped with good composition packing cups the locomotive will run a long time before it becomes necessary to clean brake cylinders.

As to other tests necessary to maintain the equipment, the air-brake man can be governed by local conditions.

Enginehouse Maintenance Organization

Therefore, for the enginehouse we have two men, each of them with knowledge of air-brake and special appliances. First is an inspector who can make and check the seven simple tests I have previously outlined and who is familiar with the I. C. C. requirements.

Second is the air-brake leadman or air-brake mechanic who should be familiar with the purposes of each part of the equipment; operation of the equipment; defects and what results different defects will produce; method of making repairs and know when it is necessary to renew parts; short cuts to get results and be able to keep the equipment operating until place is reached where proper repairs can be made; testing the equipment, and I. C. C. requirements as to tests and cleaning periods.

There are two other men who are of great value to the master mechanic, general foreman and roundhouse foreman; they are the road foreman of engines and air-brake instructor or inspector. Those two men should be familiar with the working conditions of the locomotive and all special appliances. They should instruct the enginemen in the proper operation of all the equipment and especially in proper train handling. In the maintenance of air-brake equipment and all other appliances, they should instruct the enginemen in the proper method of handling; how to test for defects; as to manner of finding and reporting defects and impress on them the importance of making intelligent work reports, and how to make repairs on the line of road so as to avoid delays or engine failures.

One of the most valuable assets is to have a road foreman who can impress enginemen with the importance of making proper work reports. One way for the general

foreman, road foreman and air-brake instructor to have the full cooperation of the enginemen in making reports to assist in the maintenance is to give the enginemen credit when due. Pay heed to their reports and listen to their complaints and grievances. The enginemen will be encouraged to tell you their troubles and will go out of their way to avoid a delay or to bring to your attention some defect that, if neglected, may tie up a division.

New Type of Officer Needed

Today the job of a locomotive maintenance officer is a real, live, "he-man's" job. Never in history has transportation demanded such real major-league talent to stay in the game. The day of the hard-swearing, tobacco-chewing, rough-neck official is a thing of the past. The locomotive maintenance officer of today is a student. He has more duties and more responsibility than ever before, and as the changes and advancements continue to increase, so do his responsibilities increase, and more and more he realizes the importance of proper maintenance. Also does he realize that to get and keep this efficient state of maintenance in the future, he needs more and more the full and hearty cooperation of all those with whom he works and with all those who come in contact with those who represent his organization.

There are many ways and means of reaching our objective, which is a higher state of maintenance and efficiency at an economical rate. As the future will bring out new designs of equipment, and new and improved appliances, so will it bring out better and improved methods of maintenance.

I have no fear; I know the class of men we have as locomotive maintenance officers, and the men working under them will meet and conquer all emergencies and will always be on top of their jobs.

Discussion

Exception was taken, by one member, to the idea of doing any maintenance work on air-brake equipment at any enginehouse on the ground that it is not feasible to equip terminals with the necessary afcilities to do a good job. This type of equipment, said the member, should be maintained only in a special air-brake repair shop equipped with high-grade facilities such as will permit first-class work on precision parts. Only in this way can this important equipment be maintained so as to eliminate failures in service. Just as an example, he said, one road went through an entire year without an air-compressor failure and, on that road compressors are now running 3½ to 4 years between replacements. This kind of service, he said, is possible only where the work is done in a specialized shop. This member recommended the establishment of a committee in the association to develop a report on shop practices in connection with air-brake work. (This recommendation was acted upon by the association's executive board and such a committee will be appointed and instructed to report at the next annual meeting—EDITOR.)

Locomotive Maintenance for Long Runs

By Lee Robinson

Superintendent of Equipment, Illinois Central

What is a long run, and what is the standard of comparison regarding proper maintenance? It is more than likely that the so-called long run is now the common run and the short run is the rarity, but we still have locomotive runs with the consequent maintenance to take care of and I do not feel it is a great deal different from formerly, especially where we are dealing with the same equipment we had in former years.

Naturally, we have a somewhat different set of conditions to consider and handle today, but it makes me feel a little put out when we ascribe them to long runs. If it was just a matter of mileage to consider, it should not cause much concern, but there is another more important factor which has entered the picture and that is speed. When the distance between final or lay-over terminals is extended and then the rate of speed between these terminals is greatly increased, new problems are injected and new costs are created which were not necessary to deal with in past years.

We are dealing with equipment, which to a large extent was designed and built for service under the entirely different conditions of 15 to 20 years ago, so that a somewhat new job must be done with old tools not particularly designed for the purpose.

Improvements Have Been Made

Naturally, improvements have been made on the older equipment to meet present-day requirements. More attention has been given to the design and application of ash pans, grates, brick arches, front-end arrangements, nozzle and stack sizes, steam distribution, driving-wheel design and lubrication. Also where boiler construction permitted steam pressures have been increased.

The general "pepping up" of this equipment to meet the increased service demands has necessitated closer inspection and working to closer tolerances than was considered necessary in the past, but if these features are not continually followed up to see that both the inspectors and the mechanics fulfill these requirements, then the desired effort is lost and troubles appear rapidly. Locomotives have a habit of showing the lack of proper attention at the most inopportune times, requiring studied explanations and much extra correspondence concerning the cause of the ensuing failure or delay resulting from some remiss action on the part of the inspection or maintenance forces. The monotony of daily routine is a factor we must all fight to prevent workmen from getting into a rut, resulting in perfunctory handling of their work, and it is more important than ever that supervisors be on the alert to overcome and remedy such a condition.

A frequent notation on an inspector's work report is "tighten bolts." This is too often taken literally by merely tightening nuts instead of investigating the cause and making the proper repairs. Wherever the use of bolts can be eliminated by redesigning, the present parts should be replaced by new parts as rapidly as possible. A loose part here and there throws an added strain on some other part which usually results in the failure of the latter. This emphasizes the necessity of making lasting repairs when such repairs are performed.

The increased vibration due to high speed causes looseness throughout the locomotive to a much greater degree than was the case in the past, and it is absolutely necessary that closer inspection and the best workmanship be obtained in making repairs, particularly to those

parts which may have a tendency to work loose in service.

Influence of Fuel and Water on Maintenance

The quality of the fuel and water available for use naturally plays an important part in the maintenance expense of locomotives, and while mechanical supervisors do not have the final decision as to the source of supply of these items, those concerned in the fuel and water supply should constantly be reminded of the importance of uniform grades of fuel and boiler water. When treated water is used systematically—controlled blowing off of the boiler on the road and at terminals will naturally reduce flue and boiler maintenance costs, as well as boiler-washing expense.

What I have said is nothing new to any of you, but I feel that constant reiteration of the right things has a tendency to make them second nature.

Naturally, "the objective of long runs is to obtain increased utilization of locomotives, but the economics of the situation existing on each railroad will eventually determine the length of locomotive runs on the various properties in the country.

Mechanical-department officers and supervisors should familiarize themselves with the operating conditions on the various divisions over which the locomotives under their jurisdiction operate, in order fully to understand the work these engines are expected to do between final terminals and handle the power to meet satisfactorily the existing conditions peculiar to those runs."

Discussion

One member made the statement that today, when locomotives were required to make runs in many cases five times as long as was formerly the case that locomotive parts had to stay tight five times as long; that it was no longer a job of going around tightening up nuts but that no effort should be spared to find out why parts came loose and eliminate the cause, by changes in the design of parts, if necessary.

A master mechanic suggested that one of the most important things today is to make sure that a locomotive is properly aligned and that a considerable improvement in condition of power had been effected on his road by checking locomotive alignment at enginehouses.

A shop foreman with previous enginehouse experience suggested that many roads were not entirely fair to apprentices in training them exclusively in back shops for service in the enginehouse at the completion of their time; that the apprentice should be given a chance by training him at an enginehouse under the conditions where he must ultimately work. By doing this the standard of enginehouse repair work can be raised.

Mr. Robinson summed up the discussion with the remark that there is still too much buck passing between enginehouse foremen and that all outlying terminal foremen should do their own work and do just as good a job as the home terminal. He also stated that one of our greatest problems is that of lubrication and that every effort should be made to improve lubrication methods.

The Responsibility of the Locomotive Maintenance Officer and the Federal Inspector

By John M. Hall

Director, Bureau of Locomotive Inspection, I. C. C.

If we use your meeting last year and your program this year as measuring sticks of what to expect in the future I can say with confidence that you will be an exceedingly valuable asset to the railroads at present and during the years to come. Railroads spend more money for locomotive repairs than for any other single item of operating expense. There is need for reduction of costs of maintenance accompanied by continuous improvement in locomotive performance and your association is one of the most effective agencies through which these twin accomplishments may be effected.

I promised to talk on the responsibility of the locomotive maintenance officer and the federal inspector. It may be unnecessary to remark that the proper carrying out of the respective responsibilities is essential if the maximum degree of usefulness of locomotives and freedom from failures and accidents is to be obtained.

The purpose of the law is to promote the safety of employees and travelers upon railroads by making it unlawful for any common carrier by railroad to use or permit to be used on its line any locomotive that is not in proper condition and safe to operate without unnecessary peril to life or limb.

Responsibility of Maintenance Officers and the Federal Inspector

Rule 102 specifies that the mechanical officer in charge, at each point where repairs are made, will be held responsible for the inspection and repair of all parts of locomotives and tenders under his jurisdiction. He must know that inspections are made as required and that the defects are properly repaired before the locomotive is returned to service.

Section 6 of the law, specifies, among other things, that the first duty of the federal inspector shall be to see that the carriers make inspections in accordance with the rules and regulations established or approved by the Interstate Commerce Commission, that carriers repair the defects which such inspections disclose before the locomotives are again put in service, and if the inspector finds a locomotive not conforming to the requirements of the law and rules, he shall notify the carrier in writing that the locomotive is not in serviceable condition and thereafter the locomotive shall not be used until proper repairs are made.

Purpose and Necessity of Daily and Periodic Inspections

It is the purpose of the daily, monthly, quarterly, and annual inspections required to be made by the railroads to disclose wear and deterioration that inevitably develops in service and to detect weaknesses that may have been unintentionally or thoughtlessly incorporated in construction or when making repairs. Vigilance should be exercised on the part of the railroads so that all defects and conditions that indicate a defect is in the process of development will be found at the inspections. If this procedure is carried out thoroughly and conscientiously and proper and timely repairs are made engine failures, which are a waste of money, and their accompanying personal injuries, which are a waste of human resources, will be practically eliminated. If engine failures or train delays must be had the proper place to have them is at the terminal where safe and economical repairs can be made.

The responsibility for thorough inspection and proper

repairs in all the various phases constitute a rather large subject running all the way from the trip or daily inspection, the monthly inspection, quarterly inspection, to the annual inspection which also includes the final inspection after the locomotive is turned out of the back shop newly overhauled and ready for another term of service.

The time is too short on this occasion to go into all the essentials of each inspection and the necessity of turning the locomotive out after each kind of inspection in such shape that it can be safely used without liability of failure for a maximum possible period of service; therefore, other than to say that maintenance officers must approve or certify to each inspection report, my remarks in this connection will be confined to the trip or daily inspection required by Rule 104 of the steam locomotive rules and Rule 203 of the rules for locomotives propelled by power other than steam. These rules are alike and read as follows:

> Each locomotive and tender shall be inspected after each trip, or day's work, and the defects found reported on an approved form to the proper representative of the company. This form shall show the name of the railroad, the initials and number of the locomotive, the place, date, and time of the inspection, the defects found, and the signature of the employee making the inspection. The report shall be approved by the foreman, with proper written explanation made thereon for defects reported which were not repaired before the locomotive is returned to service. The report shall then be filed in the office of the railroad company at the place where the inspection is made.

This trip or daily inspection, and report thereof, enables those in charge of running repairs to keep informed of the current condition of each locomotive. The value of the inspection reports in the elimination or reduction of defects depends upon the thoroughness of the inspections made, the integrity and clarity of the reports, and the amount of interest displayed by the maintenance officers having jurisdiction over repairs. It is not the purpose of the rule to permit locomotives to be returned to service with any defects in violation of the law or any rule or regulation made thereunder or with any condition that would likely develop into any violation during the succeeding trip.

We have now reached the point at which decision must be made as to what reported defects shall be made and what repairs, if any, may be deferred. It might seem to some unnecessary to say that the decision should not be based on expediency, but unfortunately we too often find that this is the case. We also sometimes find that the report is approved without any attempt to make repairs to reported defects and without any written explanation on the report as to why repairs were not made. Approval of an inspection report under these circumstances puts the maintenance officer whose signature appears thereon in a rather untenable position as he has evaded a plain requirement of the law and rules and has made his railroad company liable for the penalty provided in the law for violations of the requirements.

It is not uncommon to find the same defects repeatedly reported, together with indications that at least some attempts had been made at repairs each time reported. We have had some instances, and these seem to be increasing, where the same defects were reported time after time and notations made on the reports each time that would indicate that repairs had been made, but if made they were ineffectual and culminated in failure of the reported parts, resulting in injuries or death. Repeated reporting of any item should be ample warning that the methods of repair were not effective, that progress was not being made, and that time and money were being wasted and human life endangered. Many maintenance officers do not take full advantage of the opportunity afforded by the trip or daily inspection reports to keep informed of the sufficiency and durability of repairs. Comparisons of the items reported on individual locomotives from trip to trip will point out ineffective repair methods and can be recommended to you as a procedure that will, if properly followed up and suitable action taken, pay big dividends in reduction of defects, greater security of those who work on or about locomotives, and reduced maintenance costs. If a defective condition is repeatedly reported it is evidence that there is something wrong, therefore the cause should be found and an effective repair applied.

As an example of repeated failures most of which could have been avoided I will cite a succession of failures, on a comparatively small but important railroad which I shall not name, that I am sure none of you would like to encounter on your road. In a 12 month period, April 1, 1939, to March 31, 1940, a total of 54 stoker failures occurred; 34, or 63 per cent, resulted from failure of mechanical parts of the stokers; 10, or 18.5 per cent, were ascribed by the railroad to miscellaneous causes, worn parts, maladjustments, etc.; and another 10, or 18.5 per cent were attributed to foreign substance in the coal. By far the greater number of these failures could have been avoided by thorough inspection, proper attention to the inspection reports, and timely application of needed repairs.

It is essential that systematic procedure be adopted in routing a locomotive through the various steps after arrival and that due weight be placed on the necessity for thorough and complete inspection. Upon arrival of a locomotive at a roundhouse or shop terminal, or as soon thereafter as possible, tests should be made for blows, pounds and steam leaks before the boiler pressure is allowed to drop appreciably and all visible parts of the boiler, machinery and tender, should be thoroughly inspected and all defects found reported on the required form in an intelligible manner. In addition to the inbound inspection, parts that have been reported as needing repairs, together with all parts upon which work has been done during the lay over, should be thoroughly inspected before departure to make sure that all work has been properly completed.

Injectors, feed water heater equipment, water-level indicating devices, low water alarms, brake and signal equipment, lighting equipment, train control equipment, and other special devices should be tested and known to be in proper condition before starting each trip.

The carriers enjoying the greatest success in eliminating defects are those having a systematic outbound as well as a systematic inbound inspection.

It is a well recognized principle of all successful production methods that thorough inspection of each component part, and of the assembled unit, is essential in the control of quality and I have therefore emphasized inspection, before and after applying repairs, as a prime requisite in the process of preventing engine failures and their accompanying casualties.

I may here remind you that the requirements of the law and rules covering the construction, inspection and repair of locomotives and tenders are the rules and regulations recommended and established by the best known authorities on mechanical matters, such as the Mechanical Division of the American Railway Association and its successor, the Mechanical Division of the Association of American Railroads, locomotive builders, and standard practices adopted by the railroads prior to and subsequent to the enactment of the Locomotive Inspection Law. The requirements of the law and the rules and regulations established thereunder are not new and untried theories, but are based on well known and established practices. It is therefore essential that the officer charged with the duty of passing upon inspection reports

and necessary repairs have thorough knowledge of the requirements and be endowed with sound judgment in order that all repairs may be made in proper time and place and, in order to keep on the good side of those over you, without unnecessarily withholding the locomotive from service.

If we are to be successful in eliminating locomotive failures and their accompanying casualties we must not allow a locomotive to leave a terminal with any defect, or condition that is at all likely to cause failure while enroute. It is generally conceded that the best results are obtained if we do not permit ourselves to fall into the error of considering small defects as of minor importance. The only safe policy is the full recognition of the fact that a potential accident lurks in the shadow of many apparently insignificant defects. The mere omission of a cotter key, or failure to spread the key when applied, has too often resulted in serious failures.

We should not neglect the personal element because success in any undertaking depends largely upon human relations. Good will and mutual confidence are paramount. We all do our best work under the stimulus of encouragement and approval of the people for whom we are working. Sincere efforts to advance the legitimate interests and happiness of those whom we supervise, are more essential to success than elaborate organization or modern shop facilities, desirable as these may be.

Results from Enforcement of the Locomotive Inspection Law

In the first fiscal year of our work, which ended June 30, 1912, at which time the law was applicable to boilers and boiler appurtenances only, 65.7 per cent of the locomotives inspected by our inspectors were found to be defective and in that year 3,377 locomotives were withheld from service by our inspectors because of conditions which rendered the boilers or their appurtenances unsafe for use; in addition to these, 3,591 boilers of locomotives were either held out of service for necessary repairs or changed or strengthened to conform to the requirements of the law or permanently removed from service. This is to be compared with the fiscal year ended June 30, 1940, in which year the percentage of locomotives found defective by our inspectors was 8, and 487 locomotives were withheld from service by our inspectors because of unsafe condition of the boilers or machinery, or both.

Complete statistics of accidents and casualties for the fiscal year ended June 30, 1940, are not yet available for publication, but these will compare very favorably with results in the year 1939. Table I shows the results with respect to boilers and appurtenances only in that year compared with the first fiscal year in which the law was effective.

Table I

Boiler and its appurtenances only	Year ended June 30 — 1939		1912
Number of accidents	52		856
Per cent decrease from 1912		94	
Number of persons killed	15		91
Per cent decrease from 1912		84	
Number of persons injured	55		1,005
Per cent decrease from 1912		95	

Table II shows a comparison of the machinery accidents, the number of persons killed, and the number of persons injured as a result of failures of parts other than the boiler and appurtenances for the fiscal years 1923 and 1939.

Table II

Machinery accidents (exclusive of boiler and boiler appurtenance accidents	Year ended June 30 — 1939		1923
Number of accidents	100		839
Per cent decrease from 1923		88	
Number of persons killed	0		25
Per cent decrease from 1923		100	
Number of persons injured	109		966
Per cent decrease from 1923		88	

All of you have participated in the work of bringing about these improvements and I wish to express my sincere appreciation for the help that has been so willingly given. I feel, even without any assurance on your part, that I can depend upon you for continued cooperation.

Enginehouse Problems of the Present Day

By H. E. Hinds

Assistant Mechanical Engineer, Burlington Lines

Running an enginehouse has always presented unexpected problems and no doubt always will, as any enginehouse foreman can tell you. To get a picture of the foreman's problems, I might suggest that you pick up a copy of any recent issue of the *Railway Mechanical Engineer* and read the stories by Walt Wyre in which fact, fiction and humor are happily blended in depicting the troubles of Jim Evans, foreman of the Plainsville enginehouse of the S. P. & W. R. R.

While at first glance the picture may seem overdrawn, yet a careful perusal will show that the stories contain more truth than poetry. Whether the problems of today are more exacting than those of the past is open to argument. No doubt the Old Timer will insist that his was the harder job because of lack of modern facilities, but I doubt very much if he can get the foreman of any modern enginehouse to agree with him. Everyone at times feels that his job is much harder than the other fellow's, so perhaps by comparison we may arrive at a fair appreciation of their respective problems and a determination as to who had the harder job.

Naturally the problems both as to magnitude and frequency divide themselves into two parts, viz., main and intermediate terminals, and while the first may have better facilities, yet the difference in magnitude and frequency of problems arising at the main terminal may more than offset this difference in facilities.

The business of the enginehouse and the enginehouse foreman is to furnish suitable power to meet the demands of the traffic, and while the intermediate terminal is called on to serve but one line the main terminal may have to serve several. Therefore the latter, based on number of locomotives despatched, is plainly handicapped at the start. In addition to this, the main terminal often has problems to contend with that are not common to the other terminals.

Prior to the present high-speed age, locomotives were designed to pull tonnage regardless of speed. The result was a certain number of large heavy powerful but slow-speed locomotives. However, all traffic was not drag rating stuff. There were always a few fast freight or manifest trains mixed in, and at certain seasons of the year the high-speed stuff predominated. Naturally the large heavy slow-speed locomotives could not be used in this service, therefore where the number of locomotives adapted to fast service was limited, the enginehouse had a real problem in furnishing power to meet requirements. It was this periodical shortage of suitable power that initiated the so-called extended runs.

Happily the mechanical department immediately sensed the change in operating methods and realized that the change was here to stay. This resulted in the development of what are termed "all-service locomotives" and the modernization or conversion of existing low-speed locomotives to suit that service. This gradually eliminated one enginehouse problem, but in the interim introduced another, viz., rapid despatch through terminals.

Where the facilities are inadequate or the force limited, this introduces another problem, viz., the interruption of routine through drawing men away from their regular work to service and inspect rapid despatch locomotives. Of course, where such servicing is of sufficient frequency a regular force can be assigned to this work, but where it is only occasional, it tends to interrupt the regular routine, especially if some minor repairs are to be made on the inspection pit.

Inspection of Power

When the Federal Inspection order first went into effect a howl went up that could have been heard to the high Heaven. Time has demonstrated that it was a blessing in disguise. Had it not been for the rigid enforcement of that order, it is doubtful if the present extended locomotive runs could have been inaugurated and carried to a successful conclusion. In fact, the enforcement of this order has been so helpful that I am satisfied if a vote were taken today for and against it, the vote would be 100 per cent "for".

Under the head of inspection, we should include locomotive accessories such as air pump, stoker, superheater, lubricator, feedwater heater, booster, running and carrying gear, valve gear, power reverse gear, etc., parts which under the general order must be maintained in operative condition. Some of these introduce problems not common to the older types of locomotives and of course, items that the old timer did not have to contend with. The addition of these items to modern power affects the time element, i. e., time to make inspections and repairs and this is one of the major problems of the present-day enginehouse. In other words, "Time is the essence" of the present-day problem that causes the foreman to scratch his head and wonder how he can have one man in two places at once or do in 30 minutes a job that usually takes one hour. But somehow he generally gets away with it, much to his credit.

Many of the modern locomotives today are equipped with roller bearings on the drivers, engine truck, trailer truck or tender trucks, and some on valve gears and power reverse gears. Roller bearings on the drivers and other journal bearings have been a boon to the enginehouse forces as time savers in the quick turning of the locomotives, thereby increasing their availability.

The cast-steel locomotive bed with integral cylinders also plays an important part in the modern locomotive.

The pronounced success of specific types of mechanical lubrication, as applied in the automobile field, gave rise to their adoption on the steam locomotive. With the advent of Alemite lubrication to all valve-motion parts, together with positive lubrication of hub liners, shoes and wedges, and driving-box, trailer- and engine-truck journals and mechanical lubrication to valves and cylinders, as an absolute necessity for longer valve-ring and cylinder-packing life, enginehouse foremen were faced with the problem of reducing lubrication costs. The matter of properly applying lubrication had now been overcome, and by the regular assignment of men on each shift to handle this work, failures from this source have been materially reduced. However, there has developed the tendency to waste grease and oil. The result is that, unless a close check is maintained, the net cost of lubrication increases and the capital investment in mechanical equipment has not brought adequate return. By a proper policy of education for the man handling this equipment, and by keeping it in repair, waste can be eliminated.

As motive power assignments now include longer runs, more experienced judgment is required on the part of the enginehouse supervision, to know that all work reported has been properly performed, and the locomotive is in safe and suitable condition for the assignment. It is necessary to maintain a closer check on driving boxes, and running gear, as a number of intermediate enginehouses have been eliminated, and conditions which would enable locomotives to run 50 miles successfully, will not permit them to operate 500 miles, or more, successfully. Therefore closer attention must be paid to knocks and pounds, which are ever present, and lost motion eliminated from such important points as reverse gears, throttles, main driving boxes, etc. At monthly form periods, all items whether only of minor importance must be repaired, as locomotives despatched to outlying points invariably remain there for 30 days. No extensive repairs are anticipated at these points, as the majority of this force has been transferred to the larger engine terminals, where all repairs are concentrated, and can be more consistently handled. As extensive investments have been made in water-treatment facilities to improve boiler performance, and repair, it is necessary for the supervision assigned to boiler work to see that blowing-down is properly performed at all engine terminals, and daily checks made on the boiler water situation to prevent foaming and accumulation of solids and suspended matter.

As the turning time of power has been reduced, enabling a smaller number of units to be maintained in service, the forces assigned to engine handling and servicing must be so balanced, as to move the locomotives from the inspection pit, ash pit, coal dock and washing spot without delay. This feature of engine house operation can be definitely controlled through proper planning. Improved grate installations have reduced fire-cleaning time. Modern coal docks have expedited refueling, and improved engine washing facilities have corrected delays which were formerly occasioned from these sources.

At the present time, on most roads, Diesel-electric locomotives are handled at the same terminals as steam power. Experience gained previously with gasoline-electric power has revealed the necssity for close and detailed inspection and repair work on any type of internal combustion engine. Diesel-electric locomotives have demonstrated the absolute necessity of cleanliness in handling all work. Details of inspection must be followed closely at monthly form periods, and no items reported by inspectors or crews left unfinished, when the locomotive is dispatched. There is no such thing as deferred maintenance on Diesel-electric power, and a greater degree of foresightedness is required to anticipate certain repairs, rather than wait until excessive wear requires such repairs to be made. The supervision must be alive to special equipment necessary to handle this type of

motive power, and provide the proper tools for the mechanics assigned to this class of work. Mechanics must not be transferred periodically from steam to Diesel work and vice-versa, but must be kept on Diesel maintenance and properly trained to follow through all jobs assigned. This practice of course, also applies to those engaged in electrical maintenance on Diesel power.

Solving the Problems

Your present co-ordinated associations well point the way by which an answer can be found, viz., through co-ordination and co-operation. While the following may be common practice with most of you, nevertheless the suggestions offered may be helpful to others, and for that reason only are offered for your consideration.

A railroad is just one big organization, the sole business of which is the expeditious handling of traffic. In this organization are many departments. Naturally the closer these departments work with one another, the better the final result. Of course the enginehouse is quite remote from the executive, legal and financial departments, but it is tied in closely with the operating department. The action of either intimately or materally affects the work of the other, therefore I will confine my remarks to cooperation between these two.

The despatcher knows through his connections with other lines when and what traffic will be delivered to his line. This information is transmitted to the yard master, who in turn notifies the despatcher when he expects to have a train assembled. If now the despatcher will advise the enginehouse foreman when and what type of locomotive he will require to move such trains, giving him all the advance notice possible, it will help in the solution of the power problem. A good plan practiced at many terminals is a notification on the part of the despatcher of his requirements during the next 8 or 10 hours; this notification to be repeated at least three times every 24 hours. Where such a system does not obtain the foreman, not to be "caught with his pants down," so to speak, may fire up a number of locomotives as fast as he gets them ready, only to have them stand under steam for hours at the expense of the coal pile. Money is not so plentiful on the average railroad today as to warrant any waste in this manner.

Influence of Stores Department

A perusal of the Jim Evans stories in the *Railway Mechanical Engineer* indicates, at least by inference, that most of his troubles are due to failure on the part of the storehouse to carry an adequate supply of repair parts. This criticism may and may not be deserved. In my opinion, an examination into the facts will reveal that there are two sides to this as to any other story.

We must recognize the fact that the storekeeper also has his problems. One is always to carry an adequate supply of repair parts and yet maintain a low inventory and avoid the danger of obsolescence. The enginehouse and the storehouse have a mutual interest and by close co-operation can each help to solve the other's problems.

With the present rigid inspection and more efficient methods of repairs—welding instead of patching—the possibility of failure of any major part of the present-day locomotive is rather remote, and therefore the necessity of carrying a stock of such parts for protection at a sub-store house is hardly warranted because in case of such a failure the locomotive is usually definitely tied up long enough to get repair parts from the main source of supply. However, this does not apply to locomotive accessories where in case of failure of any part, repairs can usually be made in a few hours if proper repair parts are available. It is in this connection where close co-operation between the enginehouse and the storehouse is so helpful.

Interior parts of locomotive accessories such as air pumps, feedwater pumps, superheater units, stoker conveyor screw, etc., are not so open to inspection as are the major parts of the locomotive proper, and for that reason they may be subject to unexpected failure. True, such failures may not result in a complete engine failure, but it may result in a train delay and, if repair parts are not available when the locomotive reaches the terminal, will of course result in tying up the locomotive until the parts are repaired or new parts are sent from the main storehouse.

It is self-evident that it would take longer to remove, repair, and replace a failed part than simply to make replacement; therefore, it should also be self-evident that it is economy and will expedite out-shopping of the locomotive if substitution of the failed part can be made at once, and the failed part repaired, if possible, and returned to storehouse stock as opportunity permits. It is here that close co-operation between the enginehouse and the storehouse pays big dividends. The storekeeper has no way of knowing except from his records, just how heavily he should stock up on accessory parts, as he has no way of knowing just how many locomotives equipped with any particular accessory are working out that terminal, as the number is subject to change at any time due to transfer of power, etc. But the enginehouse foreman does know, and if he will keep the storekeeper informed, the latter can arrange for protection. It is a good idea for the two to get together, say once a week, go over the store stock jointly, agree on what should be carried on hand and what should be transferred to another storehouse when there has been a transfer of power.

Probably the greatest single change in enginehouse operation has been the training of supervision to become foreman-managers. This has been a necessity, in order to handle repair work on a basis similar to that which would apply if that foreman were handling or managing a job-shop, where all work must be turned out at a sufficient profit to make the business a "going concern." Material and labor costs are now a definite part of the knowledge of every foreman. With this knowledge it has been possible to reduce the cost per engine dispatched.

On the Burlington Lines a method is in practice for controlling locomotive costs, whereby each master mechanic is furnished each month a budget, based on anticipated locomotive miles. This budget is strictly followed, and should the actual mileage during a month be less than anticipated, adjustment in labor is made to meet the budget estimate of direct labor per mile. A follow up is made to make sure that the labor budget is not exceeded.

On account of individual locomotive cost records, it is possible to pick out the engine out-of-line in cost and make the necessary repairs.

The cost of material is checked monthly by divisions and if out of line corrective measures are taken.

Total amounts expended for running repairs are furnished by the auditor each month by divisions; material, labor and overhead are shown separately.

The master mechanic with the budget method can check the monthly expenditure with previous month's record and make corrections if necessary.

This system of accounting has developed a healthy competition among our supervisory forces at the enginehouses and shops.

Improved engine terminal facilities, both in machine tools and equipment for servicing power, have entailed a responsibility upon the supervision to see that all work

is performed safely. This feature is not an enginehouse problem, it is a duty that supervision insist upon work being performed properly and safely. It is of course definitely known that the caliber of work turned out is governed by the safe and efficient manner in which it is performed. An enginehouse foreman can no longer see that work is properly assigned to the various members of his working personnel, but he must know that cranes, hoists, scaffolding, hammer handles, chisels, ladders, slings, etc., are all in good condition, so as to avoid accidents. Today, the necessity of having trained mechanics who can work their regular assignments is too important, and the cost of their having a lost time accident too expensive to allow supervision to neglect the safe performance of work under his direction.

The advent of Social Security, and the Railroad Retirement Act, have given older employees their well earned security, at the pension age, with the result that a large majority have taken advantage of this asset. This has placed a definite responsibility upon supervision to aid in the training of the younger employees.

The enginehouse foreman, compared to back-shop supervision, has an even greater problem, because he is dealing with "live" motive power, and all weather conditions. The younger men who have finished their apprenticeship, and are working in enginehouses, must be placed with experienced enginehouse mechanics, in order to learn the methods peculiar to roundhouse work. It is not merely sufficient that one know how to do a mechanical job, but he must know that the locomotive he is working on is properly blocked and set to do the necessary work.

This is a major enginehouse problem today—the careful training of the younger men, so that they may become safe and efficient employees, and develop into future material for foreman-managers.

The Smoke Problem

The main terminal is usually located in or near a city having a strict smoke ordinance. Therefore, means must be adopted whereby locomotives may be fired up without being charged with smoke violations.

Smoke did not trouble the old timer. Quite the contrary, the presence of smoke was considered an indication of industry.

Another important problem is the one of safety. The supervisors must be safety minded in order that the men working for them be made safety conscious.

I think you will admit that the fellow near the Canadian border working under sub-zero temperatures has an entirely different problem from the fellow in Georgia whose enginehouse consists of a bunch of tracks radiating from a turntable with the blue sky for a roof. Therefore, no definite method of procedure can be laid down to suit all conditions. On the contrary, each problem must be composed as it arises, and right here let me pay tribute to that master composer—the night enginehouse foreman. The day man can consult with the general foreman or the master mechanic if faced with a tough or unusual proposition, but the night man is usually on his own. He must work out his own salvation. More power to him.

I have tried to lay down a few simple suggestions. Boiled down they spell "Co-ordination and Co-operation," but I want to add another thought. If someone has established what might be called a fence around your department, break it down. Get acquainted with the trainmaster and superintendent. You will find them good fellows who will be only too glad to help if you get up against it. After all, we are working for the same railroad and there should be no fences between us.

As R. H. Aishton once said, "If by spending an extra dollar, one department of a railroad can save a dollar and ten cents for another department, it is money well spent."

Discussion

The member who opened the discussion of the paper made the statement that the steam locomotive is on trial; that it is being challenged by the Diesel. He followed by saying that "without becoming involved in any discussion of relative costs of operation the score card after considering such items as fuel, lubrication, maintenance and enginehouse expense indicates that the Diesel may only be slightly out in front. So, what is it that stands out? It is high availability. Therefore, to find ways and means of increasing the availability of steam power would most certainly put the steam locomotive in a much more favorable position to meet the challenge of the Diesel. One of the most remarkable things about the steam locomotive is the fact that individual studies show that entire classes of locomotives on certain roads show an availability of over 90 per cent while they are actually used less than 50 per cent of the time. Lack of traffic may be part of the answer but the time spent at terminals may be the important factor. A locomotive must go through the routine of inspection, firecleaning and ashpit work, terminal movement to the house, running repairs, lubrication, service and final inspection. To increase steam-locomotive availability for service rests, to a large extent, upon our ability to reduce the time required to perform these tasks." The member then proposed several specific questions, the answers to which might serve to develop the means of increasing availability. Some of these questions were: How can inspection methods be improved; by the better training of inspectors and by the installation of improved facilities? How important is engine terminal and track layout in expediting the movement of locomotives within a terminal area? What are the most important improvements that could be made to speed up running repair work? How about lubrication; is it an important factor in the time locomotives must spend at a terminal? In answering some of these questions it was brought out that firecleaning time is often dependent on the type of grates and coal; that roller bearings have a most important influence on the time needed for repairs; that good shop tools and time-saving devices are vitally important and that force-feed lubrication on steam locomotives is of outstanding value in cutting down repairs and the consequent time spent at terminals.

A chief mechanical officer stated emphatically that regardless of any I. C. C. requirements the railroad company's requirements should be to make sure that each and every locomotive should be completely and thoroughly inspected every trip and that all necessary repairs be thoroughly made and that, regardless of destination, it is the duty of every supervisor to make sure that the locomotive is in perfect shape to go through to that destination without failure or delay.

Several members brought up the tendency for certain enginehouse foremen to pass up minor jobs and take a chance that the man at the other end of the run would do the work. This should not be tolerated, one master mechanic said, and each terminal foreman should develop the spirit of working with the other fellow to produce as nearly perfect locomotive condition as possible.

Another master mechanic said that an inspector is the kind of a fellow who likes to feel that his work is important and that if the work he reports is not done it is not fair to the inspector. If you want good inspection, he said, it is up to the enginehouse foreman to see that the reported work is done.

Refined Practices Recommended at

Master Boiler Makers' Meeting

Refinements in boiler construction methods, including the preparation of sheets, driving of rivets, welding and the use of flame cutting, discussed in reports and individual papers



Carl Harper,
President



C. W. Buffington,
← Vice-President and Chairman,
Executive Board



A. F. Stiglmeier,
Secretary-Treasurer →

NEARLY 300 members and guests attended the twenty-seventh annual meeting of the Master Boiler Makers' Association, held at the Hotel Sherman, Chicago, on October 22-25, inclusive. Short addresses by President C. A. Harper, general boiler inspector, C. C. C. & St. L., and L. B. Rhodes, president, Allied Railway Supply Association, opened the first session of the meeting. Later sessions were addressed by Dr. Edward C. Elliott, president, Purdue University; A. G. Trumbull, chief mechanical engineer, advisory mechanical committee, C. & O., and M. A. Quinn, master mechanic, D. L. & W.

Eight committee reports, three individual papers, and the History of the Association presented by John A. Doarnberger, retired, past president of the association and formerly master boiler maker, N. & W., were included in the program of the meeting. The papers were by Ray McBrian, engineer of tests, D. & R. G. W., on Service Aging of Firebox Materials; by a Committee of the International Acetylene Association of which C. W. Obert, Sr. was chairman on the Use of Acetylene Cutting and Welding in the Boiler Shop, and by Dr. W. G. Theisinger, welding and metallurgical engineer, Lukens Steel Company, on Heat and Mechanical Stresses in Welding. Abstracts of these papers will be published in later issues.

Election of Officers

At the last session of the meeting the following officers were elected to serve for the ensuing year: President, C. W. Buffington, general master boiler maker, Chesapeake and Ohio, Huntington, W. Va.; vice president and chairman of the executive board, M. C. France, general boiler foreman, Chicago, St. Paul, Minneapolis and Omaha, St. Paul, Minn.; secretary-treasurer, A. F. Stiglmeier, boiler department foreman, New York Central, Albany, N. Y.; executive board members: chairman, F. A. Longo, general boiler foreman, Southern Pacific, Red Wood City, Cal.; Sigurd Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven and Hartford, East Milton, Mass.; Frank Yochem, general boiler inspector, Missouri Pacific, St. Louis, Mo.; and E. H. Heidel, general boiler foreman, Chicago, Milwaukee, St. Paul and Pacific, Milwaukee, Wis. The following continue as members of the executive board: R. W. Barrett, general boiler foreman, Canadian National, Stratford, Ont.; C. J. Klein, retired locomotive inspector, Interstate Commerce Commission, Albany, N. Y.; E. E. Owens, general boiler inspector, Union Pacific, North Platte, Neb., and B. C. King, general boiler inspector, Northern Pacific, St. Paul, Minn.

The Master Boiler Maker—His Accomplishments and Opportunities

By M. A. Quinn

Master mechanic, Delaware, Lackawanna & Western

In speaking of the progress made in boilermaking during the last quarter century, Mr. Quinn said that our railroads have been able to obtain faster operating schedules and haul heavier trains with fewer failures than ever before because of larger and better boilers. At the same time, he continued, a far greater availability for service has been obtained from each of these traveling power-plant units than was ever possible in the past. Quoting statistics he pointed out that in 1939 the railroad of the United States moved over 913 million tons of freight and over 62 million people, the equivalent of one mile. The 24-hr. average train movement rose from 247 miles in 1920 to 400 miles in 1939. In doing this, he said, boiler efficiency has increased to such an extent that there has been a 29 per cent savings in fuel consumption in freight service and a 16 per cent savings in passenger service since 1921. Mr. Quinn continued in part as follows:

In considering the boiler we must recognize that the indispensable link between promise and performance as regards the economy and efficiency of the whole plant is the clean boiler operating with properly conditioned feedwater. Into this enters the technique we have acquired of using well designed hot-water washout systems equipped with proper nozzles and operating at correct pressures. However, the outstanding contribution in this respect has been boiler feedwater treatment. Under the guidance of our research engineers there has been placed at our disposal an adequate remedy for the mud and organic matter present in our feedwater. They have made it possible for us to approach very closely the ideal of maximum heat transmission and accurate circulation, both major determining factors in boiler performance.

No locomotive is better than its boiler. Thus, an opportunity is afforded the boilermaker above and beyond that enjoyed by most crafts to see to it that there is rendered a 100 per cent return on the investment and service possibilities that reside in these locomotives. It should be their ambition to seek constant improvement in boiler design, efficiency and maintenance. There is much still to be done to increase boiler water circulation, to eliminate or compensate for expansion or contraction stresses and to minimize temperature changes.

Some Problems of Boiler Maintenance

By A. G. Trumbull

Chief mechanical engineer, Advisory Mechanical Committee, Chesapeake & Ohio

Mr. Trumbull said that the discoveries concerning combustion conditions and the influence of combustion volume that followed the first World War and the influence of volume upon combustion efficiency were responsible for the recognition of the fact that modern transportation must depend upon effective horsepower rather than upon tractive power. This, he said, made the boiler the measure of power rather than the engine proportions, and, therefore, a number of problems which were under discussion years ago have been reintroduced and now demand solution. Continuing Mr. Trumbull spoke in part as follows:

Proper Boiler Ratios Important

The first problem is still the question of flue length, but now it is the relation of the flue length to combustion-chamber length. It is quite probable that the old relationship of heating values to length may not apply to modern high-power boilers, especially those of the Mallet and other types built for high evaporative capacity. While boiler efficiency may not be greatly affected through the use of a longer flue than is required for efficient combustion in an unusually long boiler, there may be obviously an unnecessary addition to the weight, resulting in limitations upon the design, restrictions in the movement of the locomotive, and a useless increase in the cost. It is important to an extension of the use of these locomotives that the relationship between flue and combustion-chamber length, between grate area and heating surface and between superheater pipe and flue diameters be established on such a basis as to produce maximum evaporation per pound of coal with a minimum of weight.

While the subject of flues is under consideration, it is well to remark that there are still some problems in setting that have not been completely solved. With the introduction of oxyacetylene and electric welding, boilermakers, especially those employed by railroads, were quick to perceive the advantages possible in the use of these processes for the welding of flues. There is still, however, an uncertainty as to the best method of setting the flues before welding, i. e., whether or not a copper ferrule is either desirable or necessary and whether or not a bead should be turned on the flue before welding, or whether Prossering adds to welded flue life. It is possible that local conditions may be a factor in the answers to these questions, particularly the character of water used and the rate of evaporation occasioned by the locomotive operating conditions. For this reason, these subjects offer a valuable opportunity for investigation by this association.

One of the early problems in boiler construction which influenced flue life and efficiency was the spacing of flues. Because the requirement for flue working has been so greatly reduced by welding, it is possible that our views concerning the spacing of flues may require revision.

New Problems Introduced by High-Capacity Boiler

The modern locomotive, developed from the basic consideration of horse-power rather than tractive force and requiring the evaporation of large volumes of water, has also introduced problems in maintenance not encountered or not recognized in boilers 25 years ago. The high capacity boiler with its consequent increase in the extent of boiler water treatment brought such an increase in shell cracks, especially in seams, as to prompt an investigation of the probable causes of these failures. While it is true that workmanship does have an influence upon these failures, research has disclosed that their primary source has been in the chemical action between the salts

in the treating reagents and the material constituting the grain boundaries of the steel. There are other factors that also contribute to them, especially those which tend to increase stresses in the vicinity of the overlapping plates. Thus, we have an old problem requiring new remedies for its correction and these remedies have been developed only in part.

The researches which have been conducted by the U. S. Bureau of Mines* to determine the causes of so-called embrittlement or more properly, intercrystalline corrosion, have developed that there are four major conditions, any of which may produce this corrosion.

One other subject of current importance to boiler operating efficiency and maintenance cost is the question of material for fireboxes. In spite of the general use of flexible bolts, the conditions affecting firebox life have been influenced to such an extent by high rates of evaporation, by increases in the size of fireboxes and in the working pressures carried, that the subject of firebox steel and the possibilities of increased life that might result from the use of some one of the alloys now offered for firebox applications, has again been raised.

There are other subjects that could be mentioned as having an important influence on current practice in boiler design, construction and maintenance, but your program of papers and discussions is such that it is desirable that my remarks be terminated with the suggestion that the subjects mentioned are worthy of further consideration by your association.

* An abstract of the report on the research work conducted by the Bureau of Mines on this subject appeared on page 182 of the May, 1940, issue of the *Railway Mechanical Engineer*.

Some Neglected High Pressures

By Edward C. Elliott

President, Purdue University

In the first part of his address, Dr. Elliott included a brief summary of the steam generating research carried on at Purdue University. He mentioned an investigation, under way for over three years, that has been concerned with a study of the oxidation of metals when exposed to high-temperature steam at temperatures up to 1,100 deg. F. While this investigation is still incomplete, he said, the results up to date indicated that certain alloys of steel will develop a coating of oxidation products which will protect the metal from rapid corrosion. He referred also to investigations dealing with locomotive boilers made in the past at Purdue and of more recent ones that have revealed new knowledge about forced-flow, high-pressure boilers and have resulted in new and accurate data on the viscosity of water and of steam at high pressures and temperatures.

In speaking on the subject of his address, Dr. Elliott reviewed the changes made in the long-established modes and standards of human living and working during the past two decades. No industry, no craft, no profession, he said, can expect to survive and to serve a swiftly moving today by standing still and silent in the old places of yesterday.

Continuing, Dr. Elliott spoke in part as follows:

It was during the World War of more than twenty years ago that there came under my eye a thought-provoking statement made by the President of the English Board of Agriculture. He said, "It is not a man's calling to be a laborer or a lawyer or even a land agent. In a wider sense of the word a man's calling is to be a man. When education loses sight of that it is no longer education."

For this occasion I am restating this declaration—It is not a man's calling to be a baker, blacksmith, or boilermaker—banker, bishop, or bigwig. In a wider sense of the word a man's calling is to be a man. When the worker, or those directing the worker lose sight of that, the work becomes a form of slavery.

We hear much today of the *American Way of Life,* selected and glorified as the greatest, the smoothest and the safest of all the high roads for human living and advancement. The daily happenings, throughout the world filled with conflict, chaos and fear, are compelling us to restudy this pattern of the American Way of Life; this pattern designed by our pioneering forefathers and fashioned out of the sound substances of personal industry, personal initiative, personal self-reliance, personal thrift and personal foresight.

The essence of our American Way of Life is described by the word democracy. That democracy which in terms of free men, means work for all, homes for all, health for all, hope for all, help for those ever willing to help themselves, and consequently, happiness for all; all attained through the willing cooperation of all, under the leadership of the unselfish wisest. The democracy that requires the learning of the new lessons taught by the life of each generation—the democracy that is constantly re-energized by the trained competency of the youth of each oncoming generation, and constantly revitalized by the ideals of these youth.

By far the most important of all the high pressures of modern human life comes from the inner urge of each individual to possess that liberty which will permit him, without unjust and discriminating handicaps, to gain a place on and in the American Way of Life. All government, all education, all industry, all management must recognize the fact of the existence of the individual with his own aspirations. Better boilers must not be built at the cost of worse men.

Men Must Be Analyzed as Carefully as Materials

I am aware that I am speaking to a group many of which are managers of the work of other men. As one of such managers, I have often wished that all of those who manage and all of those who are managed might learn the lesson found on one of the pages of a book that I first knew from my father's book shelf—"The Autocrat at the Breakfast Table"—by that wise man of New England, Oliver Wendell Holmes.

There Holmes points out that when Tom and Jim come together there are not merely two persons present, but six; Tom as Tom thinks he is; Tom as Jim thinks he is; and finally the real Tom known only to his Maker. Then, in a similar manner, there are three Jims; Jim as he thinks he is; Jim as Tom thinks he is; and the real Jim known only to his Maker. Here, too, originate many of the high pressures of daily life. Here management, whether charged with the making of biscuits, brake shoes or boilers, has the unsolved job of harmonizing the three Jims of the management. We shall have neither peace nor production in industry until we attempt to analyze men as carefully as we do material; until we recognize the importance of practicing the art of humanics—to use the favorite word of my late friend, Lawrence A. Downs, of the Illinois Central.

Would that I had not wasted so much of my opportunity, and had started this address with a discussion of what to me is the greatest of all the pressures of modern American life—the pressure of youth for an opportunity to become qualified to live according to the American pattern. The greatest of all the tragedies of our time is the one that has come to the young people during the past ten years, denied by the dire circumstances of the economic depression from having the traditional equality of opportunity for work. I hope that this association will not cease to proceed energetically for the widening and bettering of the chances for apprentices. The time has come in our modern economy when there is no place for untrained workers. Compulsory education should mean schooling, not merely including reading and writing, but requiring skill for a place demanding skill. We, as a people, cannot survive in a state of liberty if the land is filled with idle and untrained youth.

Thus, I stop with these references to the pressures that today all of us feel. The pressures of new knowledge—of the world conflict—of the urge of men for liberty—of the fact that men are different and not who they seem to be, and finally, the pressure of youth for its place in the world to be.

Oxy-acetylene and Electric Processes In Boiler and Tender Work

The process of welding is a most important one, and every precaution should be taken to permit only those thoroughly qualified, who have proven their knowledge and skill in this work, to perform this most important part of fabrication. We know safe welds can be obtained, if proper welding procedure is followed, and the welding operators are trained and then tested to determine their ability to produce sound welds under that procedure.

Of the major welding operations on locomotives, possibly the most outstanding application is in the welding of firebox sheets. The practice of riveting seams, or riveting patches in the firebox has almost universally been discarded, as superior results are now being obtained by welding. The advantage of the welded seam over the riveted type of seam is that it requires no further maintenance and is a perfect joint, free from leaks, such as were constantly developing in the riveted firebox. The loss of fuel from steam leaks in the riveted seams was considered a very important item, and therefore made the riveted seam very undesirable. When the flues are welded to back flue sheets, there are less leaks, therefore, a better steaming boiler. This effects a fuel saving, eliminates locomotive failures and delays from this cause, and reduces operating costs.

Shielded-Arc Process of Welding

The introduction of the shielded-arc process of welding inaugurated a new era in welding. It has improved the construction of metal products whose failure might mean loss of human life.

In the shielded arc process of manual welding, the electrode has a heavy coating which burns in the arc less rapidly than the electrode melts, forming in effect, a crucible around the arc, shielding it for most of its length. The edges of the coating, burning in the arc, give off carbon monoxide which further protects the molten metal from oxygen. The cooling metal is protected, after solidification, by a layer of slag which is the residue from the burning coating. This slag can easily be removed. Welds made within this shielded arc have a tensile strength of 65,000 to 85,000 lb. per sq. in. and ductilities as high as 20 to 50 per cent.

Joining sheets in the locomotive firebox by the electric arc process, using a heavily coated welding rod, has effected considerable economy, both in firebox construction and maintenance cost. Welds equal to or better than the plate itself in tensile strength, ductility and ability to withstand repeated stresses are obtained. The type of weld used in new fireboxes is the single-V butt weld and, as the welders have access to both sides of the sheet, the seams must be welded from both sides. After firebox has been welded completely from the fire side, a diamond-point chisel is then used and a V-shaped groove is cut in the back of the weld of sufficient depth to remove all flaws. This groove is then welded and a weld of maximum strength is secured.

In the welding of patches in fireboxes, front flue sheet, smoke box and tenders, the edges of both the old and new sheets must be clean and beveled at a 30-deg. angle, or 60-deg. opening for both. The new sheet should be bolted so that a gap of $\frac{1}{16}$ in. is left. The seam is tack-welded about every 12 in., so that the patch or section can not get out of line, after which the straps are removed. Patches or sections are applied to any part of the firebox. The first bead or pressure bead, is made with $\frac{1}{8}$-in. welding rod to insure penetration, as the weld in the water side must be clean and flush with the sheets and with no gaps or mud catchers. The first bead is laid directly in the center of the seam. No attempt should be made to fill the gap with the first bead. After the first bead is applied, $\frac{5}{32}$-in. and $\frac{3}{16}$-in. electrodes should be used and each layer of weld metal must be thoroughly cleaned of all scale.

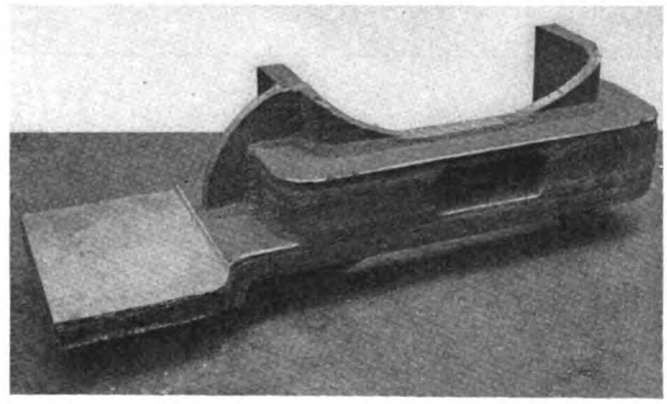


Fig. 1—Guide yoke fabricated by welding

The V-butt-weld type of joint is generally considered as the best type of construction, and is the one used in pressure vessels. To make this joint, the edges of the plate are beveled, and the welding material is deposited in a number of layers, each layer not exceeding $\frac{3}{16}$ in. in thickness, and in a definite sequence which experience has shown to be the best. Each layer is carefully cleaned before depositing the next layer.

Flame Cutting by Machine

The substitution of mechanical for manual torch operation, wherever practicable, effects better workmanship and greater economy and accuracy. Flame cutting machines have been developed which are capable of making cuts with jig-saw flexibility and of extremely high qual-

ity and accuracy. These include manual or motor-driven, partly or almost fully automatic, portable or stationary types, of various capacities. Some are equipped with two or as many as six cutting torches, centrally controlled and guided, and will flame cut simultaneously a like number of identical shapes. Machine flame-cutting is even simpler than free hand flame-cutting. Once the cutting speed and gas pressures have been set, the operation is almost automatic. As the cut progresses, the operator watches the drag and the flow of slag or oxide to prevent pockets or other defects from developing.

Mechanically operated cutting torches are rapidly being adopted for cutting various shapes out of plates and billets, and are replacing forging operations in the forge

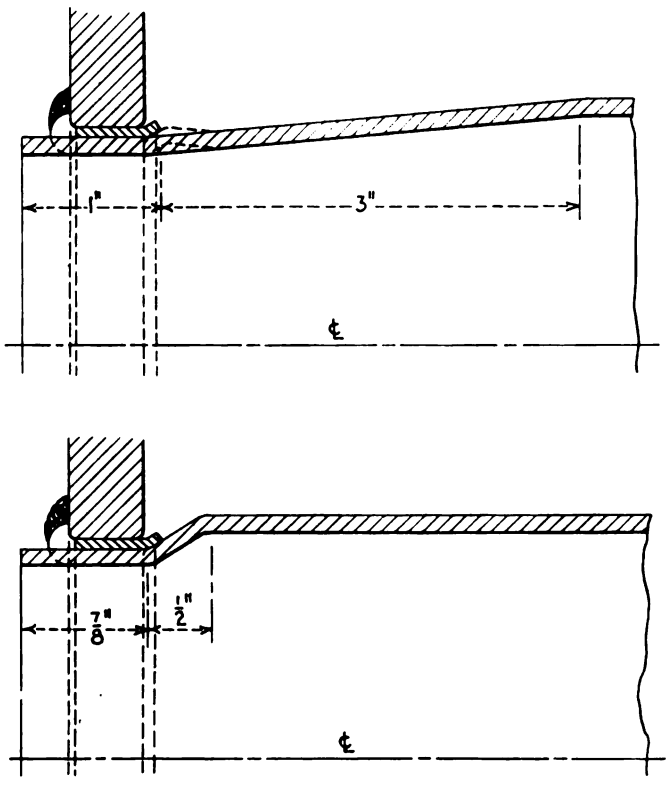


Fig. 2—Flues and tubes—beaded and seal welded

shop to a considerable extent. A saving in time and material is almost always the result in these applications, as the forging and machining operations are either eliminated or greatly reduced. These machines are also used for cutting shapes out of rolled steel for fabricating parts that replace castings, with a resultant saving in production costs, an increase in strength, and a reduction in weight.

The oxyacetylene shape-cutting machine is a recent innovation in the boiler shops, and there should be no railroad boiler shop of any size without one. In the short time that these machines have been in the railroads, their use has developed very rapidly. Each day some new operation for the shape cutting machine is found, which shows a substantial saving over old hand methods.

Firebox plates can be cut on these machines in a small fraction of the time in which they could be shaped by any other cutting method, and at a small fraction of the cost. Flame cutting can be relied on for reasonable accuracy. The squareness and clean finish of such cuts, together with the sharp top and bottom edges, compare favorably with rough machining. Where no subsequent machine finish is required, ordinary steel plate generally may be cut right to the finish line.

Questionnaire Results

Questionnaires sent out to all our members show that patches are being welded in all parts of the firebox, and that welding now plays an important part in boiler, firebox and tender construction and maintenance. The results of the questionnaire follow:

1—Welding flues and tubes to back tube sheet (all boiler styles). What method do you use? Do you weld with water in boiler, and if so, at what temperature? Do you sand blast sheet? If yes, when? Style and size wire used?

Electric arc method used 100 per cent. Sixty per cent weld flues with boiler empty, 40 per cent weld flues with water in boiler. Temperature of water varies from cold to 160 deg. F.

Seventy-five per cent sand blast sheet for welding, 15 per cent do not; 10 per cent clean sheet with grinder or roughing tool. A large majority of roads using sandblast method, sandblast sheet before flues are beaded. Others weld flues after test run. If sandblasting is used as a method of cleaning, particular care should be taken to see that no small particles of sand are left imbedded in the surface of the steel as they will cause minute blow holes or gas pockets in the deposited metal.

It is very important when applying copper flue ferrules to flue sheet, to see that, when set and rolled, they do not project out on the fire side of sheet so that when the flue is applied the copper will not project under flue beads. A proper job of welding can not be done with copper under bead. Figs. 2 and 3 show methods of welding flues and tubes.

Fifty-six per cent use 1/8-in. coated electrode to weld flues to sheet, 22 per cent use 5/32-in. coated rod and 22 per cent use 5/32-in. bare welding wire.

2—Reducing staybolt holes in the outer wrapper sheet. What method do you use? Give detailed information as to the procedure followed.

Forty per cent reduce staybolt holes by the electric arc process, 38 per cent apply threaded bushings the thickness of the sheet. Bushings are pinned tight in sheet with drift pin, chipped and bobbed up with chipping gun, reamed and tapped for staybolt. Ten per cent acetylene weld hole solid and redrill. Seven per cent renew sheets when necessary, use no welding. Five per cent do not reduce staybolt holes in outside wrapper sheet; when holes get 1 1/8-in. in diameter flexible sleeves are applied.

Roads using acetylene method to reduce holes use acetylene rod. Roads using electric arc method use 1/8-in., 5/32-in. and 3/16-in. sizes of coated rod and 5/32-in. bare wire. A method that is gaining favor in a number of shops is that when holes become larger than 1 1/8-in. a flexible sleeve is applied.

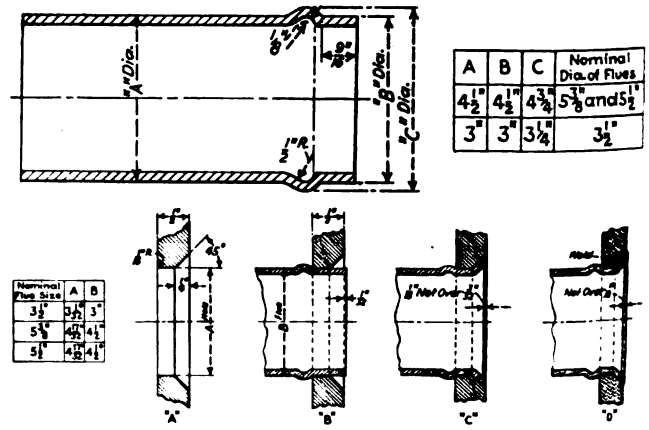


Fig. 3—Flue applied flush with sheet and welded

3—Application of the front flue sheet with the welding process. What method and procedure is followed?

Thirty-nine per cent weld in front flue sheets, 35½ per cent rivet flange and weld horizontal under braces and 25½ per cent apply flange sheet and rivet. Some reports show that if flange is good it is cut above flange and straight sheet is set in and lap welded around circumference of flange and butt welded below braces. Others apply straight welded front flue sheet. See Fig. 5.

4—Application of patches to the outer shell of vertical boiler in the stayed area. Do you apply such patches? Give full details of procedure followed.

Forty-three per cent apply welded patches to stayed areas of vertical boilers, 28 per cent apply patches with

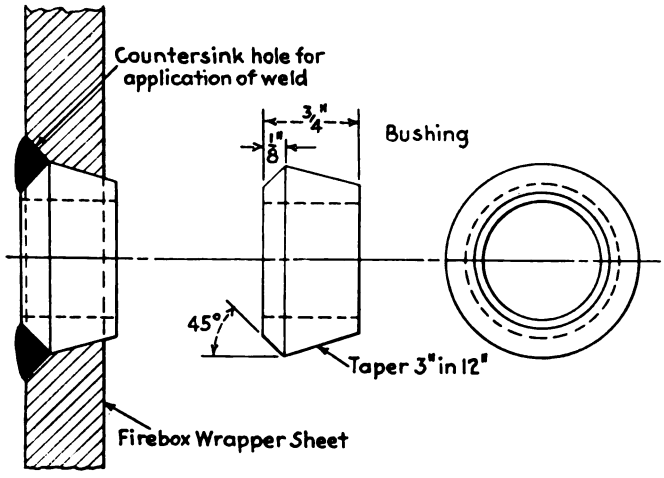


Fig. 4—Bushing applied to staybolt hole by welding

rivets or screw plugs, 21 per cent do not apply patches and 8 per cent follow A. S. M. E. Boiler Code, or State Boiler Code in which operated.

Forty-six per cent recommend welding on stayed surfaces of vertical boilers by cutting out defective section of plate, new section fitted and V-weld made with coated rod using electric process. Care must be taken to avoid welding seams through staybolt holes. Welded seams must be supported by staybolts on either side of weld. Others, when the inside (firebox) sheet is out apply a riveted patch, otherwise a butt-weld patch is made.

5—Welding of staybolts in the firebox side sheets in the fire line. Would you recommend seal welding of the staybolts in the firebox side sheets, in the fire line? Give procedure you recommend.

Seventy-eight per cent do not recommend seal welding of the staybolts in the firebox, and 17 per cent would recommend seal welding along fire line in firebox and 5 per cent did not state their recommendation. Figs. 6 and 7 show proposed methods for applying staybolts by welding.

6—Building up the sheet at arch-tube holes. Do you build up firebox sheet at the arch tube hole? Would you recommend this practice? What procedure would you recommend to follow?

Forty-one per cent build up firebox sheet at the arch-tube holes, and 59 per cent do not. Fifty-five per cent recommend building up holes, 45 per cent do not. Method commonly used is to build up ring around hole ¼ in. high on flue sheet, ⅜ in. high on the door sheet and ¾ in. wide with weld material. Fig. 8 shows a method of building up sheet by welding.

7—Renewal of fireboxes. Do you apply firebox with boiler on the frame, and what method do you follow as to welding and location of seams? Size and style wire used?

Fifty per cent apply fireboxes with boilers on frame, 27½ per cent remove boilers from frames to apply fireboxes and 22½ per cent use both methods in renewing fireboxes, on welded construction. Fifty-three per cent use coated welding rod, 12 per cent use bare wire, 2 per cent use dipped coated rod, 10 per cent use acetylene welding rod and 23 per cent did not state kind of welding rod used. Rod sizes vary from ⅛ in. to ¼ in. Welded longitudinal seams vary from 12 in. to 18 in. below highest point of crown sheet.

8—Renewing of firebox sheets. Give procedure followed and type wire used.

Seventy-four per cent used coated welding rods, 16 per cent use bare welding wire, and 10 per cent use acetylene welding rod. The sizes vary from ⅛ in. dia. to 3/16 in. The V-butt weld is used in a large per cent of cases, using a long flange on the door and back flue sheets, butt welded between the first and second row of bolts. Some prefer a lap weld with short conventional flange.

Top door-sheet patches are butt welded on door sheet and lapped or flush welded on crown sheet between first and second row of bolts. Door collar patches are butt welded. Side sheets are butt welded between second and third row above mud ring (some rivet to mud ring), and extend to crown sheet. Some report lap weld used at door sheet and back flue sheet and in combustion-chamber boxes, V-butt weld at inside throat sheet, combustion-chamber sheet and crown sheet. Butt weld is used welding sections in crown sheet and top rolls of firebox. Some prefer to lap weld door sheet and rivet to back flue sheet. For inside throat sheets V-type butt weld is used. Syphons or circulators are butt welded; a few are lap welded.

9—Tender tank; methods followed.

Patches are flush welded and ground smooth. Welding and riveting is used for full sheets. Braces and swash plates are riveted; a few use electric welding. Twenty-eight per cent have some all-welded tenders in

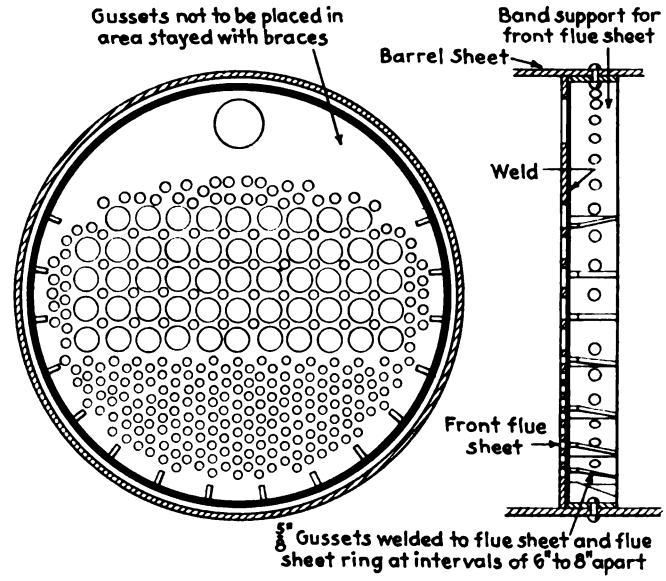


Fig. 5—Welded front flue sheet

service, 74 per cent report all riveted with the exception of welded patches. Many report seal welding seam in coal space with electric method. One road reports having 10 all welded tenders in service 12 years with very little maintenance work required.

10—Steel locomotive cabs, methods and procedure followed. Have you all-welded steel cabs?

Proposed method of securing staybolts by weld to the firebox sheets in the fire line threaded

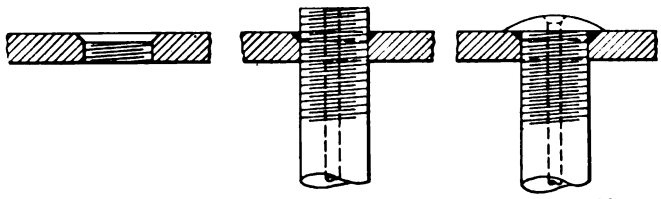


Fig. 6—Proposed method of applying threaded staybolt by welding

Twenty-nine per cent have both the welded and riveted cabs, 26 per cent have all welded cabs, 40 per cent have all riveted cabs and 5 per cent only apply flush welded patches in cabs. One road offered the following advantages for an all-welded cab: The weight of the all-welded cab is approximately 60 lb. less than the riveted cab, due to elimination of lap joints and rivets. A saving of approximately $36 is effected by the all-welded product, due to elimination of laying-out, punching and drilling rivet holes, bolting up, reaming and driving the rivets.

11—Application of flexible staybolt sleeves. What style and wire used? Do you calk sleeves after welding?

Eighty-two per cent use standard type welded sleeves, 18 per cent of the 82 per cent that use welded sleeves use threaded screw sleeves. Thirty-four per cent calk sleeves after welding, 36 per cent do not. Thirty per cent calk sleeves only when found necessary during tests. Forty-one per cent use 1/8-in. and 5/32-in. bare welding rod and 59 per cent use 1/8-in. and 5/32-in. and a few 3/16-in. coated welding rod.

12—Application of safe ends to flues and tubes. Do you apply safe ends with electric or acetylene process?

Fifty-four per cent weld safe ends on flues and tubes with the electric flue-welding process, 23 per cent acetylene-weld safe ends and 23 per cent use gas- or oil-forged method.

13—Do you remove complete fireboxes with the acetylene torch? Give detailed information as to procedure followed.

One hundred per cent remove complete fireboxes with the acetylene torch. All plates are cut into sections so that they may be conveniently handled. In connection with cutting out fireboxes, flexible bolts are reclaimed by cutting off next to sheet and cleaning by rattler method, then annealing. Radials are cut off next to firebox and wrapper sheets, also reclaimed by the same method.

14—Do you remove individual sheets with the acetylene torch? Give detailed information as to procedure followed.

One hundred per cent remove individual sheets with the acetylene torch. Burn between staybolts or split rivet seams. No. 2 size tip used.

15—Do you remove individual staybolts with the acetylene torch?

Ninety-seven per cent remove individual staybolts with the acetylene torch.

Proposed method of securing staybolts by weld to the firebox sheets in the fire line non-threaded

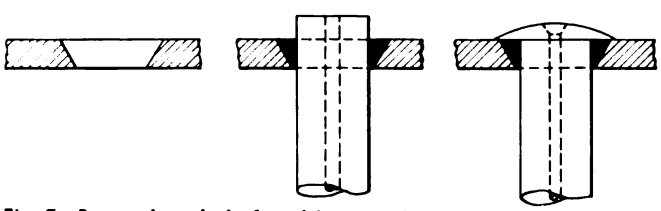


Fig. 7—Proposed method of applying non-threaded staybolt by welding

16—Do you remove rivet heads with the acetylene torch? Give detailed information as to procedure followed, and type tip used.

Ninety-three per cent remove rivet heads with acetylene torch. Rivet heads are removed by actual cutting off of the head flush with the plate, using a bent tip or by piercing.

17—Do you cut staybolts to length for driving? Give procedure followed, with style tip used.

One hundred per cent cut staybolts to length with acetylene torch. Two per cent use No. 1 size tip, 88 per cent use No. 2 size tip, 10 per cent use No. 3 size tip.

18—Do you cut out studs from boiler sheets? Give method used and style tip used.

Forty-two and one-half per cent cut out studs from boiler, 47½ per cent do not, 10 per cent cut out studs in stayed area only. Acetylene method is used in all cases of burning out studs. Seventeen per cent use a No. 1 tip, 79 per cent use a No. 2 tip, 4 per cent use a No. 3 tip.

19—Do you cut flanged sheets for chipping with acetylene torch? Give procedure followed and style tip used.

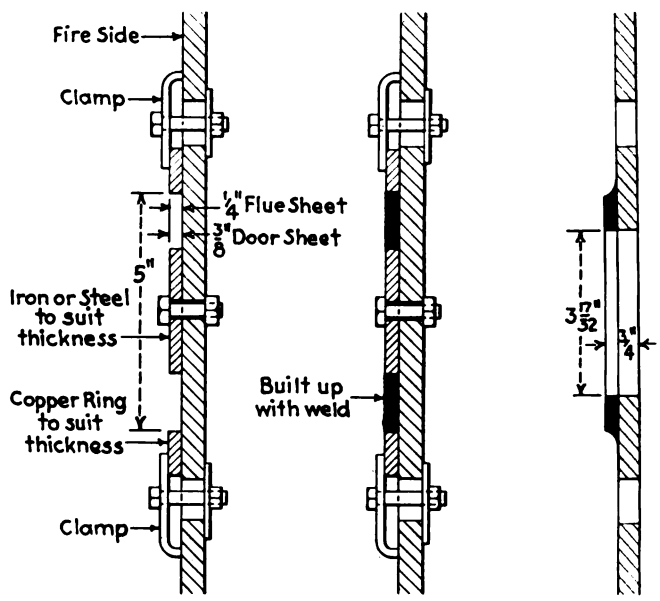


Fig. 8—Firebox sheets built up by welding at arch-tube holes

One hundred per cent cut flanged sheets for chipping. No. 2 tip is used. Sheets are then finished with air hammer and chisel.

20—Do you scarf flange of sheets with the acetylene torch in place of milling? Give procedure followed with size and style used.

Fifty-three per cent scarf flanges of sheets with the acetylene torch, 47 per cent do not. Several report no scarfing of flange sheets required as all firebox sheets are butt welded. When scarfed with torch, flanges are finished with grinder, or air hammer and chisel. No. 2 tip is used in most cases for best results.

21—Do you cut shell sheets with acetylene torch, carbon and alloy? Give methods used. Do you recommend this procedure and why?

Sixty per cent cut shell sheets, 22 per cent do not cut alloy sheets, carbon only; 14 per cent do not use acetylene torch on shell sheets, and 4 per cent cut shell sheets only when part or sections of courses are to be removed or scrapped. Eighty-five per cent recommend cutting shell sheets, 15 per cent do not. Why? Flame cutting effects better workmanship and greater economy and

accuracy. Some leave enough stock to plane or chip off.

22—Have you oxagraph cutting machine in boiler shop? Used for what purpose?

Forty per cent have cutting machines in boiler shop, 60 per cent do not. These machines are used for cutting rolled-steel slabs, all kinds of boiler and firebox plates and rough forgings.

There is no detrimental effect when low and mild carbon non-alloy steels containing less than 0.35 per cent carbon are flame cut. In an exhaustive investigation conducted by the A. S. M. E. Boiler Code Committee several years ago, the results obtained were so conclusive that all restrictions in the Boiler Code pertaining to welding on flame-cut surfaces were removed. One of the important advantages brought out was this: Where plate edges are beveled by flame-cutting and later welded together, the heat of welding anneals the base metal for an appreciable depth below the cut surface. This eliminates any change that may have been produced by the preceding flame-cutting in the crystalline grain structure of the steel.

23—Do you use the acetylene torch for heating sheets at the flange fire or in the boiler for laying up sheets?

Flange fire—79 per cent yes, 21 per cent no. Boiler—97 per cent yes, 3 per cent no.

Delaware & Hudson Fusion-Welded Boiler

The committee feels that no report on welding would be complete without the progress and data on the all-welded boiler of the Delaware and Hudson and G. S. Edmonds, superintendent of motive power, has again, as in the past, given to us progress data information:

The last inspection of this boiler was made on July 9, 1940. A hydrostatic test of 350 lb. per sq. in. pressure was applied and an inspection showed the welded seams in good condition. The approximate mileage was 169,000.

The report is signed by Frank A. Longo (chairman), general boiler foreman, Southern Pacific, Bayshore shops, San Francisco, Calif.; A. F. Stiglmeier, vice-chairman, boiler department foreman, N. Y. C., West Albany shops, Albany, N. Y.; J. D. Seivewright, welding inspector, Canadian National, Toronto, Ont.; D. P. Smith, general boiler foreman, C., B. & Q., Burlington, Ia., and V. B. Vogel, supervisor of welding, C., R. I. & P., Silvis, Ill.

Discussion

The discussion centered around the use of coated welding rod in the welding of staybolt sleeves. The representatives of two railroads stated that heavily coated welding rod can be used successively for the welding of these sleeves. However, in answering the question of whether this welding can be done in any position, one of the representatives said that in his shop the boilers were positioned to accommodate the welding. Another speaker in commenting on this problem said that heavily coated welding rod could be used for all work, including the welding of sleeves, if the correct equipment was employed.

Pitting and Corrosion on Firebox Sheets Back of Grate Bearers

Authorities inform us that there are at least eight fundamental causes for pitting and corrosion in locomotive boilers. Any one of these causes, or any combination may produce pitting or corrosion. However, in regard to the type of corrosion which forms behind the grate side bearers there seems to be one fundamental cause, ash accumulation and the presence of moisture and oxygen.

The presence of ash accumulation behind grate bearers and dead grates is due to those parts being improperly designed or poorly fitted, leaving pockets or recesses for the ashes to lodge. This, combined with the presence of moisture due to leakage, rain and snow being drawn in with the draft, injector overflow, waste steam from cab heaters, continuous blowdowns, washing out ash-pans at cinder pits, condensation, etc., provides ideal conditions for corrosive action. Thus, the elimination of this condition is mechanical rather than chemical.

This corrosion is the result of oxidation and other chemical reactions to which metallic parts are subjected by action of liquids and heat. The extent of the corrosion is limited only by the amount of moisture and the quantity of ash or soot. Corrosion is most prevalent in fireboxes at localized sections, namely, behind grate bearers and dead grates or any other parts where ash accumulation is allowed to remain in contact with metal and moisture is present.

The primary cause of this form of corrosion is the products of combustion. The sulphur content of the coal, ½ to 2 per cent of the total weight of the coal, is one of the chief causes of corrosion. Sulphur (S) burns, combining with oxygen (O) to form sulphur dioxide (SO_2). This gas is rapidly taken up by moisture, water, steam, etc., forming sulphurous acid (H_2SO_3). This acid chemically reacts with iron (Fe) forming hydrogen gas (H_2) and iron sulphite (Fe S). The salt (Fe S) falls off the metal leaving grooves, pits and pocks in the sheets, rivet heads, support lugs and brackets, etc. The sulphur dioxide (SO_2) may be further oxidized to form sulphur trioxide (SO_3) which is dissolved in water forming sulphuric acid (H_2SO_4). The amount of sulphur dioxide (SO_2) forming sulphur trioxide (SO_3) is very low, about 98 per cent of the damage being done by the sulphurous acid (H_2SO_3).

It is also suggested that a further contributing cause for this corrosion and pitting is sloughing, and that this sloughing is caused by uneven expansion which occurs at the bottom of side sheets, door sheets and flue sheets. This uneven expansion is caused by grate side bars, grate bearers, grates and dump grates. These parts, ten per cent of the total grate area, with the exception of the dump grates are immovable and are holding places for all dead ash and clinkers. This causes the lower section of sheets to have a lower degree of heat than the fire line. This variation of heat causes the sheets to slough at these points.

Design of Grate Bearers

The consensus of opinion is that grate bearers should be so designed that the top section will fit close against the side sheets, chipping them to fit if necessary, or applying a liner wedge if the mudring is bowed outwards. The suggestion of applying strips of asbestos between top of bearer and side sheet is commendable and less costly than fitting.

One railroad reports: "That during the time the burning of the Rosebud coal was being made a success, preparations and experiments were made to a large extent with the regulation of draft and the amount that could be admitted through the grates for the successful burning

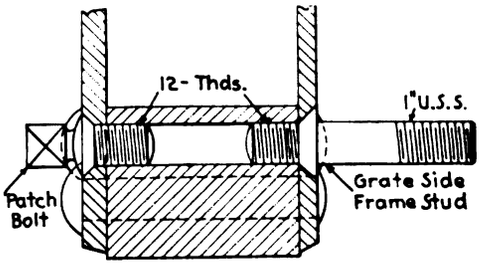


Fig. 1—Stud for supporting side bearers

of this light, often very fine coal. It was after these experiments in which we had made exceptional efforts in closing excess openings that we also learned the value of tight fitting grate bars and dead grates in relation to pitting and corrosion of sheets behind them. Much of that power that has been so carefully equipped for burning of this coal, after about ten years, show no pitting, whereas sheets in power not so carefully equipped continue to waste away with the resulting costly repairs."

On the other hand, others, recommend that grate side bearers should be kept back from side sheets, and that the opening at the top of the bearer be smaller than the

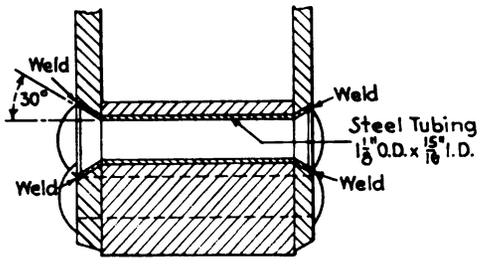


Fig. 2—Method of applying steel tubing

opening at the bottom so that ashes or coal that can enter between the top of the grate bearer and sheets cannot be trapped back of bearer but will fall through to the ashpan. This method is satisfactory providing other measures are taken to deflect the cold air away from the firebox inside sheets.

Another suggestion which should be well worth considering is that grates could be so designed that the side bars and end bars will be fastened to the under part of the mudring, making as near 100 per cent movable parts of grates as possible. This, we believe, would do away with all dead places in the firebox, and would destroy the slow burning sulphur gases and keep them from attacking the lower section of firebox sheets, would check the cold air from coming up alongside the sheets causing staybolt leaking at the fire line, would give better combustion in the firebox, would mean better steaming engines and fuel economy, as all gases would be burned.

The top side of bearers should be designed with a slope inwards which would allow the fine ash to fall away from the side sheets. There are two common methods of supporting side bearers, viz: the bearer bar stud as shown in Fig. 1, and the supporting bracket which is fastened by studs to the bottom side of the mudring. The objection to the latter is that it forms a base for ash accumulation, while the bearer stud is often a source of leaks and frequently requires renewing when bearers are removed. Fig. 2 shows a method which has been adopted and which eliminates the objectionable features of the bearer stud and effects a considerable saving.

With the best designed grate bearers and ashpans there will be some accumulation of ash, especially where moisture is present resulting from firebox leakage. Consequently a number of our railroads have instituted periodical removal of side bearers and cleaning of sheets behind same. This has been found to be the best retarder of this form of corrosion, the extra time and cost involved has been justified by the longer life of the side sheets. Some recommend a three months' cleaning period, others six months, while the majority have found that removing side bearers and thoroughly cleaning sheets with a wire brush or sand blasting at each annual hydrostatic test has been sufficient.

This cleaning should be followed up by painting on some form of preservative which will aid in retarding the corrosion. A number of our members have reported beneficial results from painting on red lead, freight-car red, front-end cement, or high heat-resisting paint. This following formula has been recommended as giving good results: 12 lb. iron oxide paste, 10 lb. Portland cement, 1½ gal. turpentine, 1½ gal. linseed oil, making five gallons of mixture.

It is suggested that metal spraying of sheets behind side bearers with aluminum or bronze will prevent this form of corrosion. However, from inquiries made it is learned that a number of railroads have been experimenting along these lines for the past ten or twelve years but so far the results do not appear to justify the cost of spraying.

Cold-Air Deflector Plates

A number of railroads attach deflector plates along the side of fireboxes for the purpose of deflecting cold air away from the firebox sheets which help to prevent excessive staybolt leaking. These deflector plates have, in a number of instances, been responsible for much of the trapping of ashes behind bearers with the resultant corrosion.

Fig. 3 shows a design of deflector plate which formed a pocket behind side bearers and was the cause of extensive corrosion of side sheets and ring, necessitating renewal of sheets behind bearers every four or five years.

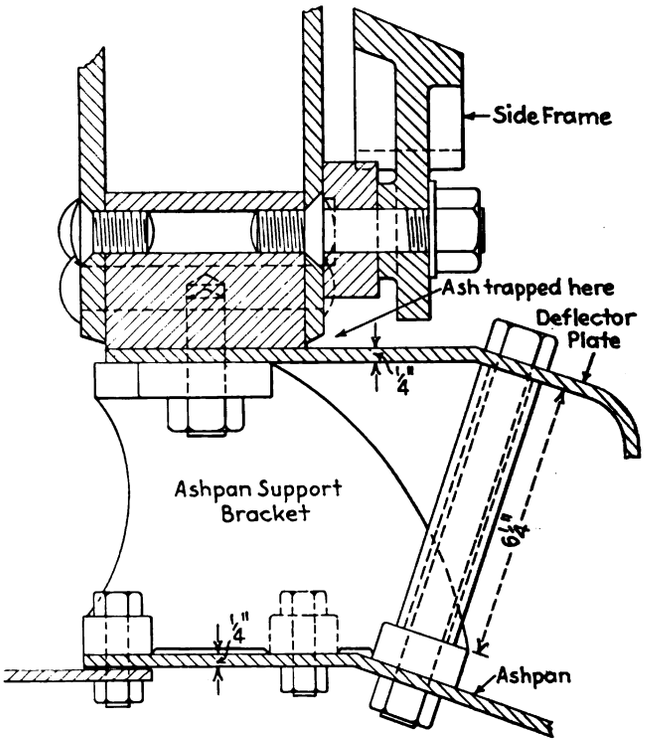


Fig. 3—Original method of applying cold-air deflector plate

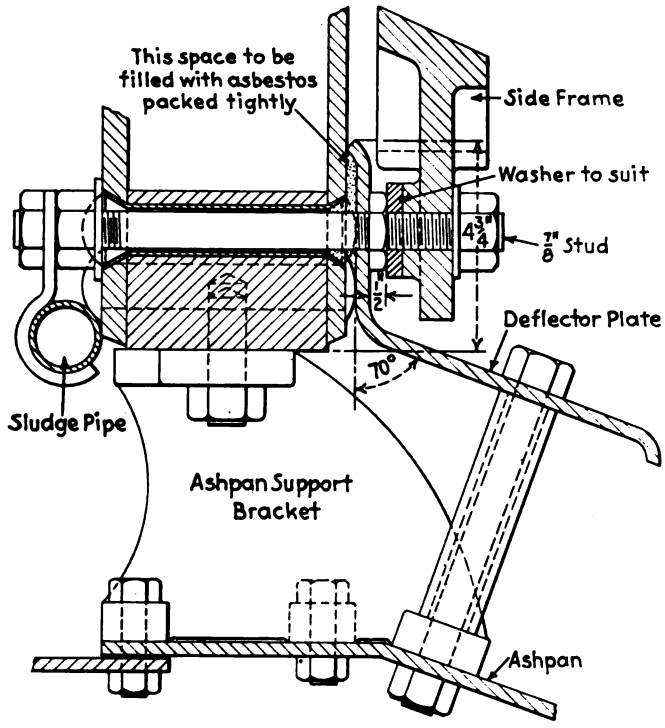


Fig. 4—Improved method of applying cold-air deflector plate

By changing the design to the one shown on Fig. 4, the ashes were permitted to fall away, and side sheets after a recent test of four years showed no indication of corrosion.

The committee makes the following recommendations: Side bearers and dead grates should be designed so that ash and fine coal cannot accumulate behind them. At each annual test and inspection side bearers should be removed and firebox sheets thoroughly cleaned and painted with an approved preservative. All rivet holes in foundation ring behind bearers should be countersunk and shallow head rivets applied. When cold-air deflector plates are used they should be so designed that no accumulation of ash against the side sheets is possible. When locomotives are to be stored for a number of months grate bearers should be removed and sheets thoroughly cleaned by sand blasting or by the use of a wire brush and a rust preventative paint should be applied.

The report is signed by R. W. Barrett (chairman), general boiler foreman, Canadian National, Stratford, Ont.; F. Yochem, vice-chairman, general boiler inspector, Missouri Pacific, St. Louis, Mo.; A. P. Roberson, district boiler inspector, Great Northern, St. Paul, Minn.; A. W. Novak, general boiler inspector, C. M. St. P. & P., So. Minneapolis, Minn., and H. P. Butler, chief boiler inspector, Bangor & Aroostook, Derby, Me.

Discussion

In discussing this problem, one member stated that the practice on his railroad was to apply asbestos between the mud ring and the ashpan and to weld the seams in the ashpan to prevent air leakage. For oil-burning locomotives another speaker said that the side sheets were cleaned when renewing the side brick. This is done approximately three times yearly. After cleaning, the sheets are wire brushed and then painted with red lead. Another member suggested that the side sheets be welded to a cast-steel mud ring, eliminating the rivets and thus the corrosion of these rivets.

Means to Improve Water Circulation in the Boiler

In compliance with the recommendation of the 1939 committee, our Executive Board has divided this topic into four sub-topics, each of which will be discussed in the order of its relationship to the general topic.

Increasing Feedwater Temperature

The means to increase feedwater temperature are already available and in use to a considerable extent. But the temperature needed to reduce or prevent the shock of impingement and the temperatures obtained with the various heating arrangements are worthy of consideration.

First, it might be stated that the temperature of the steam and at least the major part of the water in the boiler with 200 lb. per sq. in. pressure is 388 deg. F., with 250 lb. per sq. in. pressure it is 406 deg. F. and with 300 lb. per sq. in. pressure it is 422 deg. F. Twenty-five years ago there were few boilers with more than 200 lb. per sq. in. pressure. Today, there are a good number with 300 lb. per sq. in. pressure. The pressure has been increased 50 per cent but the temperature only 34 deg. It is, therefore, not temperature but temperature differences that must be considered.

Live-steam injectors, live-steam boosters, feedwater heaters and exhaust-steam injectors during most of the operation of the locomotives deliver the water to the boilers heated to temperatures between 175 and 250 deg. F., depending upon pressure and temperature conditions. The water already in the boilers is at a temperature in the neighborhood of 400 deg. F. The water delivered to the boilers, is, therefore, at temperatures 225 to 150 deg. below the temperature of the water already in the boilers. We are therefore interested in heating the entering feedwater all or part of this additional temperature. When the feedwater at this lower temperature is delivered to the boiler through a side boiler check, it tends to sink to the bottom of the boiler. If the locomotive is operating at a medium or high output, there is a vigorous circulation in the boiler. The water is rapidly mixed and there can be very little or no measurable difference in temperature of the water in different parts of the boiler excepting right at the inlet. If, however, the locomotive is drifting or standing there is little or no circulation and there is an accumulation of water in the lower parts of the boiler that is at a lower temperature than the water higher up in the boiler.

These differences in temperature of the water and also parts of the boiler cause contraction and expansion strains that are presumed to be the cause, or one of the causes of boiler trouble, particularly firebox sheets and staybolts. Therefore it may be presumed that this subtopic refers to the possibility of the reduction or elimination of these temperature differences as a possible cause of these troubles, either by the additional heating of the feedwater by live steam, or, by the better mixing of the entering feedwater with the water already in the boiler.

With the advent of the feedwater heater, the top boiler check has come into almost universal use. That part of the top check through which the feedwater is discharged into the steam space of the boiler has been the subject of much study and experiment for many years. Practice has settled down to a more or less standard form of spreader which divides the entering water stream into two streams pointed to each side and some form of plate

or discharge box over the dry pipe. In order to obtain more prompt and more complete heating of the water as it enters the steam space, there has been developed a spray nozzle to take the place of the spreader. The water issuing from the spray nozzle in the form of an umbrella shaped film is immediately broken up into a spray, as it is struck by the steam it condenses, and complete heating is assured.

Where the side boiler check is preferred, an upturned elbow extension inside the boiler may be used. This arrangement has been in use for a number of years on some of our railroads and was described in the proceedings of the International Railway Fuel Association for the year 1930. The entering feedwater is directed upward by the elbow and more completely mixed with the water in the boiler.

The combination of the feedwater heater and the top boiler check is an ideal feedwater heating arrangement. The feedwater heater secures all the advantages of heating by exhaust steam at all of the operating conditions of the locomotive. The top boiler check secures the advantage of heating by live steam, as well as water at the same temperature throughout all parts of the boiler and almost complete elimination of the shock of impingement.

Improper Firing Practices Detrimental to Water Circulation

In order that we may fully cover this sub-topic it is necessary that we set down in the order of their importance the various firing practices that we know to be detrimental to circulation and from this we can find the means to reduce or eliminate these improper practices. Speaking broadly, it may be said, that any firing practice that permits of the fluctuation of steam pressure is detrimental to circulation and should be entirely dispensed with if possible. Fluctuations in steam pressure occur both on the road and at terminals, and while it is felt that the more pronounced fluctuations occur at terminals during the lighting-up and fire-cleaning periods, it should be the most easily corrected due to the presence of supervision at all times, while the fluctuations occurring on the road, are, in most cases due to operating conditions and are not so easily controlled.

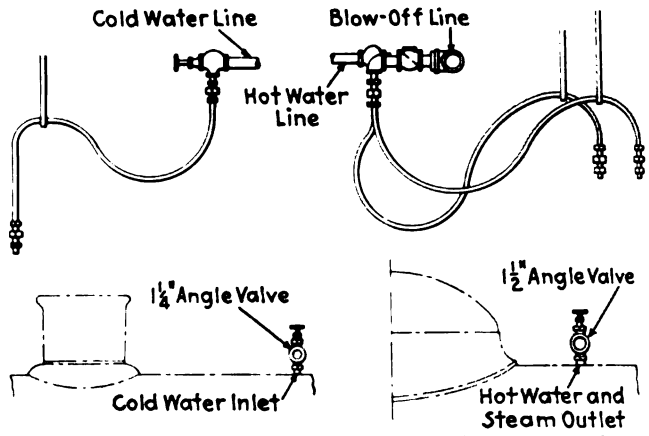
From the information furnished by the members it may be said that the following practices are the most detrimental to circulation: Too rapid raising of steam pressure when lighting up engines, failure to cover grates properly with coal when lighting up engines, excessive use of blower when lighting up and when cleaning and dumping fires, unnecessary lifting of safety valves while engine is on dispatch track, excessive working of injectors and water pump and opening of fire door to prevent safety valves lifting, permitting fires to die down while waiting for trains to be made up in the yard, carrying water too high or too low in the water glass, and lack of uniformity in firing.

The coal should be fed only in sufficient quantities to maintain the amount of evaporation consistent with the work being done by the locomotives. The coal should be uniformly and evenly distributed over the entire grate surface. If too much coal is put in one spot it will choke off the necessary air required for proper combustion.

The detrimental effects on locomotives as stated above are equally applicable to oil burning locomotives.

Proper Firing Up and Cooling Down of Boilers

With the advent of the present large high-pressure locomotive boilers, the question of the proper method to be followed in the firing up and cooling down of these boilers to reduce or eliminate strain has been given much thought and study. It has been said that the best way



Suggested arrangement for cooling down boilers at terminals

to wash a boiler is to do it only as it is absolutely necessary, and as the same holds true in cooling down boilers, they should be cooled down only at washout periods, unless, in exceptional cases, it is necessary to cool them down to make certain repairs which cannot be done otherwise.

From the information furnished by the members it is found that the number of railroads using the hot-water wash-out system is about the same as those using the cold-water wash-out system. Regardless of whether hot or cold water is used in boiler washing, the boiler should be cooled down to the approximate temperature of the wash water, either by natural or artificial cooling. As the time limit enters into the boiler-washing schedule it is necessary in the majority of cases to use an artificial method of cooling down the boiler.

The various cooling-down methods in use are similar in that they accomplish the same purpose. However, it is felt that a system of cooling down boilers might be suggested that could be applied to all terminals at very little cost, and with this thought in mind we are offering for your consideration a system we believe will most fully meet the requirements.

The accompanying diagram shows in detail the necessary connections for cold water inlet and the hot water and steam outlets. The cold water inlet is located preferably in the delivery line to the boiler check while the hot water and steam outlet is located on top of the boiler or in the dome cover.

When an engine is to be cooled down either for work or for wash out, if under steam, the inspirator is to be worked until the boiler is completely filled or the inspirator breaks. The cold water hose will then be attached to the filling valve on the delivery line to the boiler check and the blow-down hose attached to the cooling valve on top of the boiler or dome. Next, cold water will be admitted through the filling valve, allowing the hot water to escape through the outlet valve and continued until the temperature of the boiler corresponds to the temperature of the washout water. The time required will vary from two to four hours, depending upon the temperature of the washout water used.

In cooling down oil-burning locomotives at least five hours should be allowed between the time the burners are shut off and the cooling down process is started to permit the brick work to cool down. Otherwise the cooling down process will require a longer period and a greater amount of cold water will be used.

We believe that a majority of the railroads have written rules covering the time allowed for lighting up and generating steam in locomotive boilers and it is certain that all have unwritten rules. We have to consider, however, that in spite of rules prohibiting practices detri-

mental to boiler efficiency, service demands may cause locomotives to be fired up and under full steam pressure well under the time limit that would permit the temperatures in the boiler to be equalized. This is particularly true of oil burners as it is possible with a cold boiler to light them and have a full head of steam in forty-five minutes with the result that the lower part of the firebox and casing are relatively cold when the safety valves are blowing off. This is due to the protective brick work which extends to some height at the back end and sides of the firebox, which takes a considerable time to heat up sufficiently to enable it to transmit heat to the firebox sheets.

In view of the fact that the greater number of locomotives in service on our railroads are coal burners, we feel we should consider the firing up of this type locomotive in general, and that we should consider the boiler had been cooled down for wash out.

When wash out and all work inside the firebox has been completed, the boiler is filled to two gages and grates are covered with coal, care being taken that coal is spread evenly over the entire grate surface. The fire should be started slowly, using an oil torch to ignite the coal and only sufficient blower should be used to clear the stack. The fire should be light at first and uniform over the entire grate area and steam pressure raised gradually. At least one hour should be consumed in raising the steam pressure to 50 lb. per sq. in., two hours for 100 lb. and three hours for 200 lb. Under no circumstances should the fire lighter or hostler be so neglectful as to cause the safety valves to lift while the locomotive is on the dispatch track.

Design of New Boilers to Improve Water-Carrying Properties

In discussing this sub-topic, the committee has considered only the conventional steam boiler, for while the water-tube-type boiler has made very marked progress during the past few years, it is felt that this type of boiler is still in the experimental stage and will not be in universal use for some years to come. When locomotive boilers were enlarged and steam pressure increased, an increase in circulation became necessary and the arch tube was developed. This created greater heating surface and increased circulation. Later, when the need for greater heating surface and circulation became imperative The Locomotive Firebox Company came forward with the Thermic Syphon and afterwards, The American Arch Company with the Circulator. These gave the desired increase in heating surface and circulation without the necessity of materially increasing the dimensions of the firebox.

With the increased rate at which boilers are required to furnish steam, some designers have found it expedient to increase the heating surface by placing the crown sheet relatively higher with respect to the center line of the boiler which permitted the installation of additional rows of flues. This, of course, decreased the steam space but the liability of carry over of water was increased.

In designing the locomotive boiler, the designer must consider keeping the crown sheet low enough to permit as much steam space as possible. At the same time he must consider heating surface and amount of water required. The width of the water space between the inside and outside sheets must be large enough to permit free circulation.

The present conventional type steam boiler cannot be materially changed in design without sacrificing some definite requirement of design. However, there are certain items of construction that may be considered to improve the water-carrying properties. These will be discussed in the summary of the requirements necessary to meet the conditions brought forth by the various sub-topics.

Summary

In summing up the various sub-topics, we are submitting to the association officers and executive board certain things which we believe should be submitted to the membership of the association for their consideration as standard practices, also suggestions that a further study be made of other items with a view of setting further standard practices or recommendations to the Mechanical Division, Association of American Railroads.

General Topic—Use of live steam connection in bottom of first barrel course to increase circulation at that point during firing up period. Use of sludge remover extending along bottom of barrel and connected to blow-off cock at throat sheet, sludge-remover pipe to have openings in the bottom of the pipe at first barrel course equal to area of the blow-off-cock opening to remove sludge accumulating at that point and to increase circulation adjacent to the front tube sheet. One blow-off cock to be located at either right or left back mud ring corner connected to a pipe extending across the mud ring and having openings in the bottom equal to the area of the blow-off-cock opening to remove sludge and increase circulation at the door sheet.

Increasing Feedwater Temperature—Fill-up connection should be applied to the intake section of the tube bundle on feedwater heaters of this type and the boiler filled up through the bundle. The water passing through the tubes under pressure will help keep the tubes clean.

Improper Firing Practices—We believe that a committee of the Association should work in conjunction with a committee of the Railway Fuel and Traveling Engineers Association with the view of setting up instructions covering improper firing practices.

Proper Firing Up and Cooling—The proper firing up and cooling of large high-pressure locomotive boilers is mainly one of supervision, the strict enforcement of present rules, and the adoption of any that will improve boiler conditions.

Design of New Boilers—In the design of new boilers consideration should be given to the application of Thermic Syphons and Circulators to increase the heating surface and improve circulation, the lengthening of the combustion chamber for added heating surface and to decrease the length of flues and tubes, maintaining the crown sheet low enough to provide not less than four inches of water above the highest point of the sheet and to provide sufficient steam space to reduce the liability of carry over of water, increase in width of the foundation ring over the conventional 5.5 inch and the possibility of the outside dry pipe as a means of preventing water carry over.

The report is signed by E. H. Gilley (chairman), general boiler foreman, Grand Trunk, Battle Creek, Mich.; M. V. Milton (vice-chairman); H. E. May, shop engineer, Illinois Central, Chicago; Fred C. Reinhart, general boiler foreman, A. T. & S. F., Ft. Madison, Iowa; E. Crapper, chief boiler inspector, F. C. S. & F. C. O., Argentine Republic; H. L. Harrell, general locomotive inspector, Illinois Central, Chicago; C. A. Brandt, chief engineer, Superheater Co., New York.

Discussion

One member stated that his railroad was experimenting with boilers having water-feed fireboxes and these have proven satisfactory to date. Another member said that his railroad had applied three tubes on each side of the firebox, connecting the water space just above the mud ring to the tops of each of two firebox syphons.

Treating Boiler Feedwater Chemically

This is a continued subject and it was the desire of the committee to submit their report in such a manner, if possible, so as to avoid repetition or duplication of the many fine reports which have been presented on this subject during the past few years. Our investigation has developed that there has been no substantial change other than extension of use, either in the type of chemicals or the methods of application which were fully described at the 1939 meeting. Such success as has been achieved is believed to be the result of careful check and supervision together with the coordination of the application of the necessary chemicals with the conditions developed and noted in the boiler shops and roundhouses.

The subject was divided into sub-topics, evidently with the view of attempting to obtain information which would reflect the definite improvement that has been made. Accordingly, a questionnaire including twenty-one items was sent out to all the membership of the association under date of April 15, asking for detailed figures on the respective items for the years 1930 to 1939, inclusive. Unfortunately it has not been possible to obtain the information desired as the serious business depression which extended over the major portion of the period covered was of such intensity that only a few of the railroads have maintained records in sufficient detail to permit a general effective comparison. [A summary of the reports by five railroads was included.—Editor.]

Savings Effected by Feedwater Treatment

The replies to the questionnaires indicated that some form of treating boiler feedwater chemically is being used on most of the railroads and that considerable improvement in boiler conditions and reduction in maintenance expense has resulted, as well as a saving in fuel. It was not possible to obtain definite figures covering the actual saving in dollars and cents during the last decade, but it appeared to be very generally agreed that the operation of locomotives in competition with various other forms of transportation would have been exceedingly difficult if advantage had not been taken of securing better boiler conditions by improving the quality of the water used.

Reduction in Pitting and Corrosion

The estimate shown in the replies to the questionnaire indicated a reduction of between 80 and 95 per cent in the pitting and corrosion on locomotive boilers. This is a remarkable reduction and shows that the proper treatment of the water supplies has had a direct bearing on the condition of the boilers.

Fortunately, the most practical treatment for preventing the formation of hard and destructive scale deposit has also been found to be the most effective means for reducing pitting and corrosion. The Water Committee for the American Railway Engineering Association found that the addition of sufficient soda ash, or equivalent chemical, to the boiler water in amount to maintain an alkalinity in the actual boiler water of at least 15 per cent of the total dissolved solids, will generally minimize both scale formation and corrosion. In practice, it appears advisable to maintain this excess alkalinity at a minimum of 20 per cent to reduce corrosion and a maximum of 30 per cent to avoid accentuating the foaming tendencies of the water.

The increase in the period between washouts to the full 30-day limit, where practical, by proper control of the concentration by regular concentration tests, has also had a direct bearing on the improvement in the condition of fireboxes. It is believed that more trouble is now being experienced with cracking and checking on the fire side than with corrosion on the water side, especially in the boilers operating over 250 lbs. per sq. in. pressure.

Blowdown Methods and Control

It is believed that one of the biggest steps in improvement of boiler conditions took place with the realization of the importance and effect of proper blowdowns. This has not only resulted in assisting to remove the mud and precipitated matter from the boilers but also is a means of controlling a concentration of dissolved solids in order to permit boilers to run a full 30-day limit between washouts.

The fundamental method for controlling blowdowns of the dissolved solids is a test made of the boiler water samples at the locomotive terminals to check up on the amount of blowing which has been done by the road crews and also to determine the amount of dirty water that must be removed and replaced with fresh water in order to send the engine out in satisfactory condition. This testing of the concentration was first made with hydrometers or densimeters, but a considerable improvement has been effected with the development of the electrical conductivity equipment which registers the concentration on a direct scale reading after adjustments have been made for temperature. This equipment is available from several sources and many railroads have installed these testers at all of their important terminals.

The blowdown of boilers in service is more difficult to handle on a practical basis. The first method used and one that is still in effect on many railroads is the intermittent use of the large blowoff cock at designated points or at times which are left to the discretion of the engine crews. Experiments have been carried out with a view of developing a dependable and satisfactory automatic arrangement which will take the operation of the blowdown equipment out of manual control. In some cases, the use of the continuous blow has proved very satisfactory, either controlled by the manual opening at a valve or operated automatically whenever the throttle is open. One manufacturer has a device on the market which is in the nature of foam-collecting trough which is connected to a blowoff cock that opens automatically whenever the trough becomes filled with water. This device is being used on some railroads but it has not been in service sufficiently long to afford a comparison between the benefits and the additional maintenance cost of the equipment.

Individual reports were included on this subject from B. C. King for the Northern Pacific and C. A. Stuebben for the Texas and Pacific. A paper was also included by J. P. Powers, vice chairman of the committee, with the assistance of C. E. McCoy, chief engineer, National Aluminate Corporation; F. B. Horstman, technical director, Dearborn Chemical Company, and R. E. Coughlan, engineer of tests, C. & N. W.

The report is signed by E. E. Owens (chairman), general boiler inspector, U. P., Omaha, Nebr.; J. P. Powers (vice-chairman), system boiler inspector, C. & N. W., Chicago; C. A. Stuebben, general boiler foreman, T. & P.; B. C. King, general boiler inspector, N. P., St. Paul, Minn.; R. C. Bardwell, superintendent of water supply, C. & O., Richmond, Va., and G. N. Hagan, supervisor of boilers Erie, Meadville, Pa.

Discussion

One railroad had experimented to find out the resistance of boiler-plate, nickel-steel and silicon-manganese-

steel specimens to caustic embrittlement. Embrittlement detectors were used. At the end of the test period, the boiler plate was found to be in good condition while the nickel and silicon-manganese steel were badly cracked.

Another speaker stated that his railroad had placed five passenger locomotives of the 4-8-4 type on fast freight runs. The staybolts of these locomotives immediately started to leak very badly. This leakage was stopped by the application of the continuous blow down using $\frac{5}{32}$-in. and $\frac{7}{32}$-in. orifices, one on each side of the locomotive, and by the introduction of organic material to the boiler feedwater.

Application of Iron, Steel and Alloy Rivets

The high capacity of modern locomotives brought about by the use of high steam pressure and high superheat temperature has required the use in many cases of alloy steels, more exact workmanship in laying out and fabrication of the boilers, and better maintenance and operation than was required with older locomotives. Little printed matter is available on these important subjects and it is the desire of the committee to present such comments and recommendations as are reflected by practical experience. The committee desires to recommend to the association only such methods which we know are attributes to first class workmanship. We believe the standards set up by the association should be consistent with the scientific development of boiler design and the demand which is made for keeping the power in operating service continually.

During recent years much study has been given to failures which have developed from the cracking of shell sheets from rivet holes, both in carbon-steel and alloy-steel sheets, and it is apparent that such fundamentals as design, material, fabrication, water treatment and the washing, firing up and blowing down of boilers must be given consideration in our endeavor to overcome the troubles which have been experienced.

Boiler Design

While the design of boilers is not within the province of the boiler maker, the designer can modify and improve the design only through experience gained by the boiler maker in maintaining tight seams and tight boilers, which are essential to successful operation. Care and thought must be given to the location and type of seams, as very often leakage develops because riveted seams are improperly placed and designed. The circumferential seams of large high-pressure boilers are often a source of trouble particularly near the bottom center line of the boiler as the restricted clearances of modern locomotives makes access to these seams difficult. A number of members of the association recommend that circumferential seams, particularly between the first and second boiler courses, be triple-riveted rather than double-riveted on large diameter boilers. Caulking of these seams both inside and outside is recommended. The importance of tight longitudinal seams was stressed by W. C. Schroeder of the Bureau of Mines at the 1939 meeting of the association. A method of hydrostatically testing longitudinal seams has been outlined to the committee whereby a hole in the butt strap is drilled and tapped for ¼-in. pipe after which hydrostatic pressure is applied and the seam made tight before application of the flues to the boiler. The hole for the pipe connection is, of course, plugged when the tests are completed.

Boiler and Rivet Material

A number of members of the association prefer carbon steel for both shell sheets and rivets to alloy steel, probably on account of troubles experienced with boilers containing alloy steel. Apparently, however, the successful design of large high-pressure boilers demands the use of alloy steel. This subject is receiving a great deal of thought and study by the American Society for Testing Material, the Association of American Railroads and metallurgists generally. Successful use of alloy steel in boiler construction is confidently anticipated by this committee.

While it is not the desire of the committee to enter a discussion of the relative merits of the various kinds of steels, the following information, abstracted from a letter by A. L. Roberts, Development and Research Division, of International Nickel Co., is considered important: "We wish to advise that the following is our recommended nickel steel for use in locomotive boilers, for rivets:

Carbon, per cent	1.90	(minimum)
Manganese, per cent	0.15	(maximum)
Sulphur, per cent	0.30	0.50
Phosphorus, per cent	0.045	(maximum)
Silicon, per cent	0.040	(maximum)
Nickel, per cent	0.15	0.30

"This steel is recommended for longitudinal seams only; straight carbon steel is recommended for the girth seams. The following are the physical properties of this recommended rivet construction:

	Bars up to 1 in. Diameter	Bars over 1 in. up to 2 in.
Tensile strength, lb. per sq. in.	65,000	60,000
Yield point, lb. per sq. in.	45,000	40,000
Elongation, per cent in 2 in.	28	25
Reduction in area, per cent	45	40

"Heretofore we have recommended S. A. E. 2115 steel, which is a higher-carbon, 1½ per cent nickel steel.

"The inside edges of the nickel steel plates of girth seams should be caulked the same as the outside edges of the seams. The hydraulic pressures used on nickel-steel rivets should not exceed 100 tons for rivets up to and including $1\frac{1}{8}$-in. diameter, nor 125 tons for rivets up to and including $1\frac{5}{16}$-in. diameter. All hydraulic riveters should be equipped with a recording pressure gage so that a permanent record may be kept. It will also provide a check on the men operating the riveter. In heating the rivets for driving in nickel-steel plate, the temperature of the rivets should be limited to 1,500-1,800 deg. F. All rivet heaters should be equipped with recording pyrometers which will give a permanent record of the temperatures in case of any trouble."

Boiler Fabrication

In fabricating non-pressure vessels the use of sheets sheared or cut by the acetylene torch to size and rivet holes punched to size are permissible. For pressure vessels, however, sheets should be laid out from blue print or template and rivet holes in shell plates and flanges of heads or flue sheets should be drilled, and reamed to size. Staybolt holes should be drilled ¼ in. smaller than the diameter of the stays required and be reamed and tapped after fitting up. Shell courses after forming should be sandblasted inside and out, and thoroughly inspected for laminations, pitting and impregnations of mill scale before being assembled. Plates should be sheared or burned ¼ in. to ⅜ in. away from the shear line and planed back to the shear line to take off all

hard and burned metal. They should also be planed to form proper bevel. Tool marks along planed edges should be removed by grinding and sharp edges should be removed from holes before rolling. Cylindrical boiler courses should be rolled true to form and all butt straps properly formed with true radii, and be well set up, metal-to-metal, to the connection sheets before sheets are drawn up tight together. Springing of the sheets, or drawing sheets together other than tightening the connection for riveting should not be permitted.

All connections of boiler courses should be made with connecting sheets parallel for a distance over the width of the lap sufficient to provide a straight surface for the caulking edge of the overlapping course. Sheets should be fitted up as tightly as possible and in proper alignment with each other before any holes are reamed. When courses lap over or under other courses circumferentially they should be rolled with a ring between the roller and the sheet for a distance equal to the width of the lap in order to provide a true bearing on the adjacent parallel courses. Flanging a tapered course on a bull machine to make it fit adjacent courses should not be permitted.

After rolling and flanging of each shell course has been completed, temporary butt straps or suitable clamps should be applied to the longitudinal seam for the purpose of holding it in position and alignment during the welding at the edge of the sheets. Assemble shell courses, by heating if necessary, and properly align all courses, making sure that the boiler is level both horizontally and vertically, in every respect. Then apply bolts in every other circumferential-seam rivet hole. Bolts are to be pulled up tight to give metal-to-metal contact at all points; if not, they should be set up to a metal-to-metal contact before any reaming and riveting is done.

Weld longitudinal seams at both ends; chip and grind welds flush with surface of the plate. Remove temporary butt straps and fit inside and outside butt straps metal-to-metal with the boiler, bolting every other hole. Draw the sheets to an actual metal-to-metal contact and without removing the fitting-up bolts, ream and slightly countersink the open holes inside and outside. Having fitted butt straps and reamed the open holes, ream and slightly countersink all open holes in circumferential seams. Do not remove fitting-up bolts.

Drill rivet holes in the dome after flanging and trimming has been completed. Properly fit and bolt the dome liner in place. Fit the dome to the boiler, and with it in proper position drill the shell to the dome base rivet holes, using the dome as a template. Remove the dome and dome liner and eliminate all burrs. Reapply the dome liner, and bolt to the boiler through every other hole, drawing the sheets to a metal-to-metal contact. Then, ream and slightly countersink all open holes, inside and outside. Rivet all open holes through the sheet and liner except those in the dome base. Reapply the dome and bolt to boiler through every other hole, drawing the sheets to a metal-to-metal contact. Ream and countersink all open rivet holes, inside and outside.

Drive all rivets in open holes in longitudinal seams; remove fitting-up bolts, ream and slightly countersink the balance of the holes, inside and outside, and complete riveting the seams. Drive four rivets on each quarter of each circumferential seam; then drive rivets in all open holes. Remove fitting-up bolts, ream and slightly countersink the balance of the holes inside and outside and finish riveting the circumferential seams. Drive all rivets in open holes in the dome, remove the fitting-up bolts. Ream and slightly countersink the balance of the rivet holes and complete riveting of the dome. Complete riveting of the dome may be done, if desired, before the courses are connected.

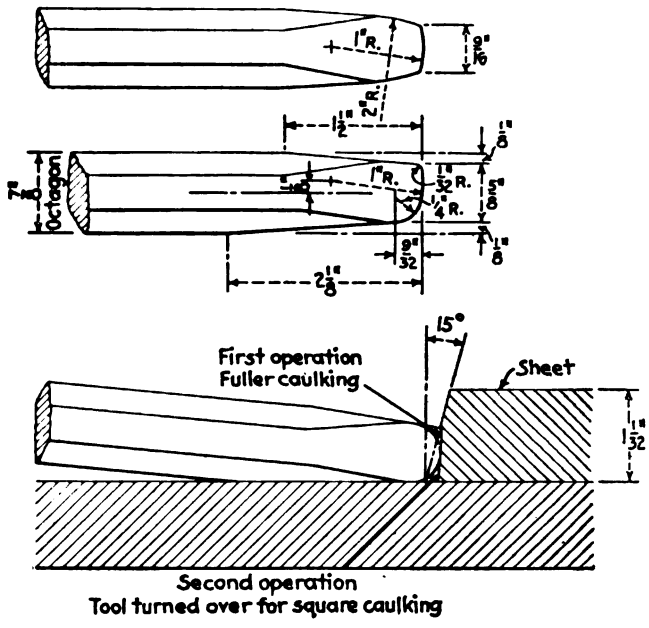


Fig. 1—Caulking operations

All butt straps, domes, dome liners, and flanged sheets are to be properly formed, have true radii, and are to be set up metal-to-metal to the connecting sheets, with the maximum opening at any point not exceeding .005 in., nor extending over one-half pitch between rivets. All circumferential- and longitudinal-seam bevels and the area around rivet holes between contact surfaces should be cleaned as may be necessary in order to obtain smooth surfaces for a metal-to-metal contact.

All boiler course seams and butt straps, inside and outside, are to be caulked, wherever possible. The caulking tool shown in Fig. 1 is recommended. Other caulking tools are shown in Fig. 2. All rivets inside and outside of the boiler should be caulked, and the following tools are recommended for rivets: burring tool to cut off collar, and light round nose fuller for caulking.

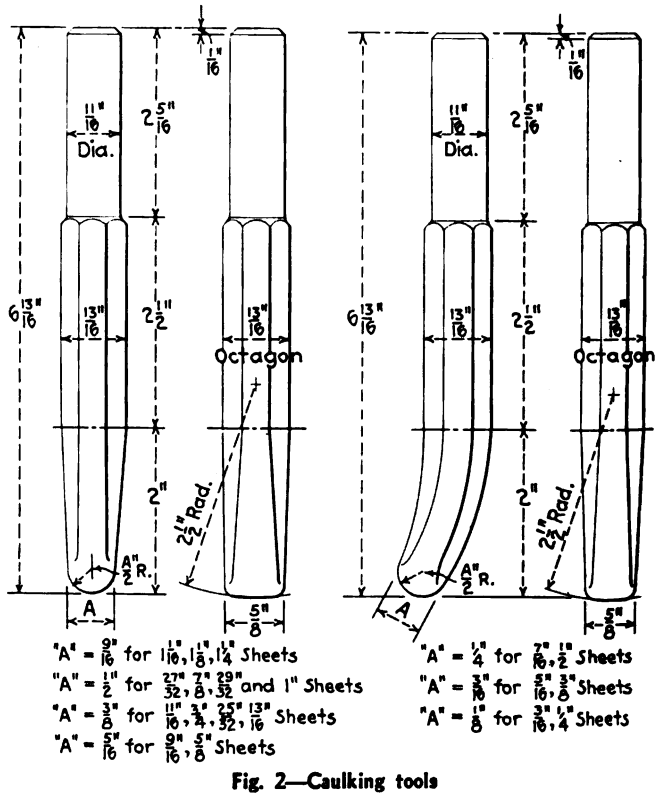


Fig. 2—Caulking tools

Rivets and Riveting

The following information, furnished by C. P. Diemer, works manager, Champion Rivet Co., was considered by the committee to be of very considerable interest and importance to members of the association:

"There is little printed matter available on the subject of rivets and riveting, and our comments reflect our experiences on the subject merely as manufacturers.

"Rivet making falls into two classes—hot forming, and cold forming. Hot formed rivets can be made in all diameters from ½ in. upward. Cold formed rivets are made in all diameters from ⅛ in. to 1 in. Standard cold heading equipment has a length limitation of about 4 in., hence all rivets, regardless of diameter, longer than 4 in. must be hot formed. However, equipment is available for heading small wires under ¼ in. diameter into long rivets such as are used in some types of crating, but such rivets or pins are not classed as rivets.

"It will be noted from the above that there is a certain range of sizes which can be made either by the hot or cold process. The determining factor in the choice of process usually lies with the purchaser. The first rivets used were hot formed in hand dies, and the hot-forming machine was an outgrowth of this process. Consequently, many users of rivets adhere to hot-formed rivets because of habit. These rivets have inherent deficiencies such as scaled surface, a pinched end due to being hot sheared, fins along the shank due to manufacture in open dies, a wide variation in gage sizes which is also due to open dies requiring rivet holes 1/16 in. larger than the rivet. In large size rivets which must be produced by the hot process, all of these inherent deficiencies can be corrected by further processing.

"Cold-formed rivets have the advantage of being formed from bright round wire. They are usually made in solid die machines, and have a smooth surface, a round shank, a square end, and a narrow range of gage sizes which enable them to be driven into rivet holes 1/32 in. larger than the rivet. There is a decided trend toward the use of cold-made rivets in all sizes up to and including ⅞ in. diameter. This type of rivet is well suited to heating in electric rivet heaters because of its superior workmanship and finish.

"Riveting also falls into two classes—hot and cold. Each method of riveting is further divided into hand or gun driving, and bull or power riveting. Hand or gun driving has the advantage of flexibility enabling the operator to drive in close quarters and difficult positions. This method is limited to rivets under 1⅛ in. diameter although with careful procedure, larger sizes can be handled satisfactorily.

"Bull or power riveting has the advantages of (a) greater power which enables the operator to completely fill the hole; (b) a steady squeezing pressure which upsets the entire mass of metal in the rivet at one time as compared with the repeated light blows of the pneumatic gun; (c) the use of lower driving temperatures which reduce the amount of scale formation; (d) the ability to hold pressure on the rivet until it has cooled below the critical temperature range of the rivet, viz.: 100 deg. F., and (e) reduced physical effort on the part of the operator. The bull riveter, of course, has the limitations of bulkiness and lack of portability and can be used only on straight-line riveting within the range of the gap dimension.

"Cold riveting ordinarily requires an annealed rivet if it has the conventional round or cone head. A special type of flat rivet is now used in large quantities for cold riveting without any annealing. Both cold-made and hot-made rivets contain internal stresses at the head due to forming, and should be annealed if they are to be cold driven. Cold riveting is done preferably with pneumatic or hydraulic riveters of the squeeze type. This equipment is available in portable designs and often is light and flexible enough to reach difficult spots in the structure. (Hanna Engineering Company, Chicago, can furnish considerable data on this type of equipment.)

"Considerable research has been conducted on cold riveting, and many tests show that such rivets have a greater strength, a closer fit, and a tighter grip than hot-driven rivets. This applies, of course, to rivets 1 in. and under in diameter, because although rivets have been cold driven successfully in diameters up to and including 1⅝ in., it is difficult to obtain test plates with these larger sizes.

"The advantages of cold riveting are: (a) lower labor cost as no heater is needed; (b) saving of fuel; (c) faster assembly because rivets can be placed in holes by hand instead of with tongs, and also well in advance of

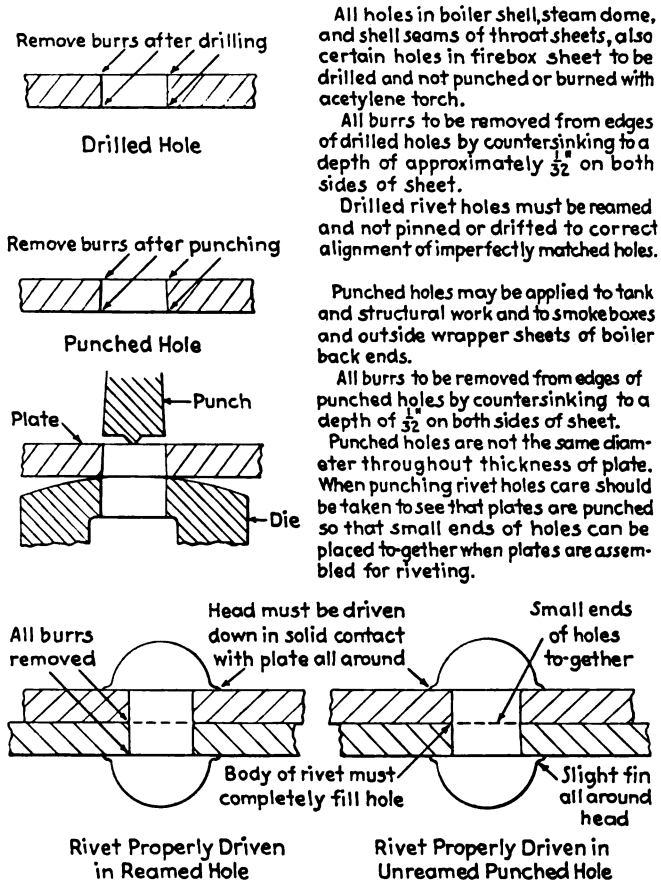


Fig. 3—Recommended riveting practice for punched and drilled riveted holes

the riveter; (d) tighter fit because the hole can be reamed smaller without allowance for expansion due to heating, and (e) lack of scaling caused by heating.

Design of Rivets

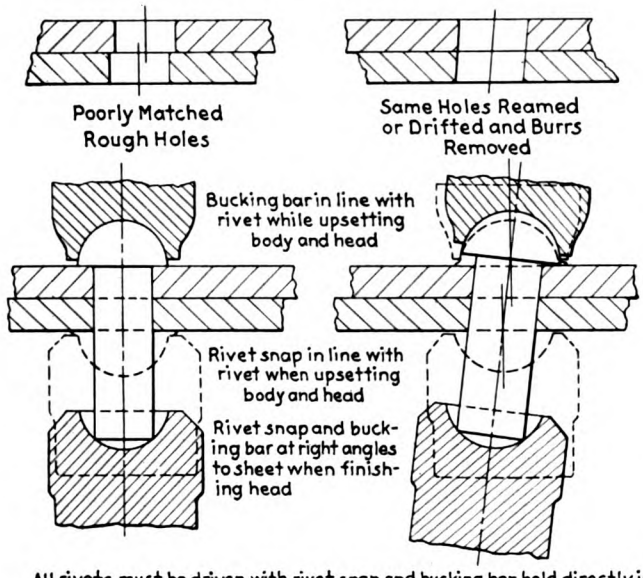
"Wherever possible all rivets should have fillets under the head. A 1/16-in. radius is satisfactory on sizes from ¾-in. to 1⅜-in. diameter. Larger fillets are better but plates should be prepared to receive them. On stainless, high manganese, and alloy rivets, it is necessary to use ⅛-in. radius on all sizes from ½-in. diameter and upward. This method is seldom used but the experience of those who have tried it gives amazing results.

"In cold riveting a thin flat head will give better results than the conventional button head. These heads present an unusual appearance which tends to retard

their adoption but sufficient experience has already been developed to prove the efficiency and economy of their use. For hot riveting it is recommended that either cone or acorn heads be used, and reformed in driving to a button shape. The shape of these heads permits the flow of metal from the head into the rivet hole, and aids in securing a tight job, and is practically essential on long rivets through four or more thicknesses of plate.

Plates and Rivet Holes

"Riveting of pressure vessels requires careful preparation of the plates and rivet holes. Of course, no holes should be punched. They should be drilled, and after



All rivets must be driven with rivet snap and bucking bar held directly in line with body of rivet until body of rivet is fully upset so as to completely fill rivet hole, after which snap and bucking bar should be held at right angles to sheet for a few strokes while finishing the rivet head

Fig. 4—Recommended practice for rivet driving

bolting in position should be reamed to $\frac{1}{32}$ in. oversize for rivets up to and including $\frac{7}{8}$-in. diameter; $\frac{1}{16}$ in. oversize for larger rivets unless they have been especially processed. With accurate True Tolerance rivets, $\frac{1}{32}$-in. clearance may be used for hot riveting on all sizes up to and including $1\frac{1}{4}$-in. and $\frac{3}{64}$-in. for larger sizes.

General

"Riveting in general has been conducted in a rough fashion. Precaution as to condition of the holes, the tolerance on the rivets, the heating methods, temperature, shape of rivet heads and sets, riveting power, careful timing, all pay well in the final results obtained. We have seen boilers under 700 lb. per sq. in. hydrostatic tests with no caulking and no leaking. Such a result is due only to meticulous care at every step in the assembly process. We would judge that these extra precautions were worth while in the savings made in touching up bad joints and rivets, or replacing poorly driven rivets, and in the long-lived service rendered by the vessel."

Rivets may be heated in an electric heater, a gas or an oil furnace. They should be heated slowly, the heat being so applied as not to overheat the outside surface before the center is heated to proper temperature. Do not apply heated rivets in holes more than ten seconds before driving nor apply a rivet in next hole before driving the first rivet. All rivets after being heated must have scale removed before inserting in rivet holes.

All rivets should be driven with dies that form neat heads with the flash not less than $\frac{1}{16}$ in. in thickness. Avoid die cutting into the sheet. To prevent excessive heating of the sheets in riveting seams, alternate the riveting by advancing the riveting in the second row far enough ahead of the first row so as to avoid localizing the heat. This procedure is to be followed at all other points where the driving of a number of rivets at one time in a small area is liable to cause excessive heating of the sheet.

If driven by a hydraulic riveter, the driving pressures and holding time should be substantially as given in the following table:

Carbon and nickel steel rivets, diam., in	Driving pressure on rivets, tons	Minimum holding time, seconds
$\frac{7}{8}$	60 to 65	6
1	75 to 80	8
$1\frac{1}{8}$	85 to 90	10
$1\frac{1}{4}$	100 to 105	12
$1\frac{3}{16}$	115 to 125	12

When driving tee-iron rivets, the tonnage used should be kept as low as possible to prevent spreading of the hole in the tee-iron. Figs. 3 and 4 show recommended practice for punched and drilled rivet holes, and rivet driving.

Tolerances in rivets in general have been allowed in a very rough fashion, and it has become apparent that some consideration must be given to the wide range rivet tolerance in approved A. A. R. tolerance specification, particularly rivets of the 1-in. to $1\frac{3}{8}$-in. sizes These specifications permit variations from basic diameter of .027 in. undersize to .035 in. oversize. Recent tests conducted with $1\frac{3}{16}$-in. rivet holes in plate for $1\frac{1}{8}$-in. basic diameter rivets, but with the rivets machined so that the body diameter varied from the basic size to the full extent of this .027 in. minus to .035 in. plus range, but accomplished in steps of .005 in. increasing and decreasing from basic size showed the following: The rivets were driven in their respective holes at a temperature between 1,800 and 1,900 deg. F. and at an actual driving pressure of 91 tons on the rivet. The heads at one end of the rivet were then machined off to study the tightness of rivets in plate. It was found that rivets with body diameter .014 in. or more below basic diameter were loose in plates, while rivets driven with body diameters .020 in. or more above the basic diameter caused hole distortion in the plates which was noted in the caulking edge of the seam.

It is recommended that consideration be given to establishing tolerances for 1-in. to $1\frac{3}{8}$-in. rivets for locomotive boilers not to exceed .010 in. minus and .020 in.

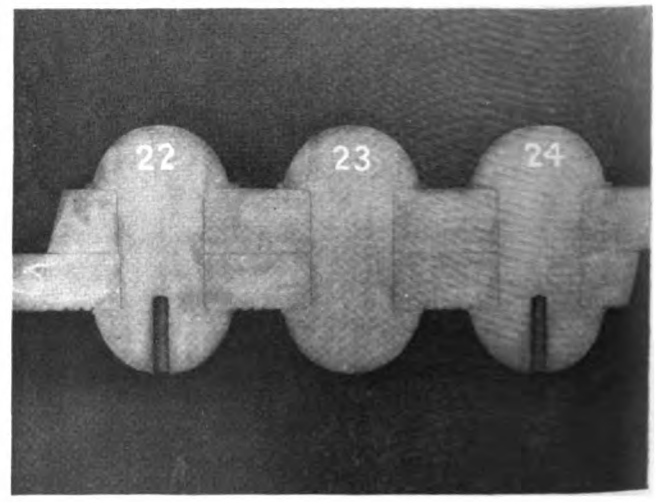


Fig. 5—Rivet No. 22 shows rivet hole enlarged toward the caulking edge—Rivets Nos. 23 and 24, driven with correct tonnage, show rivet holes in perfect alinement

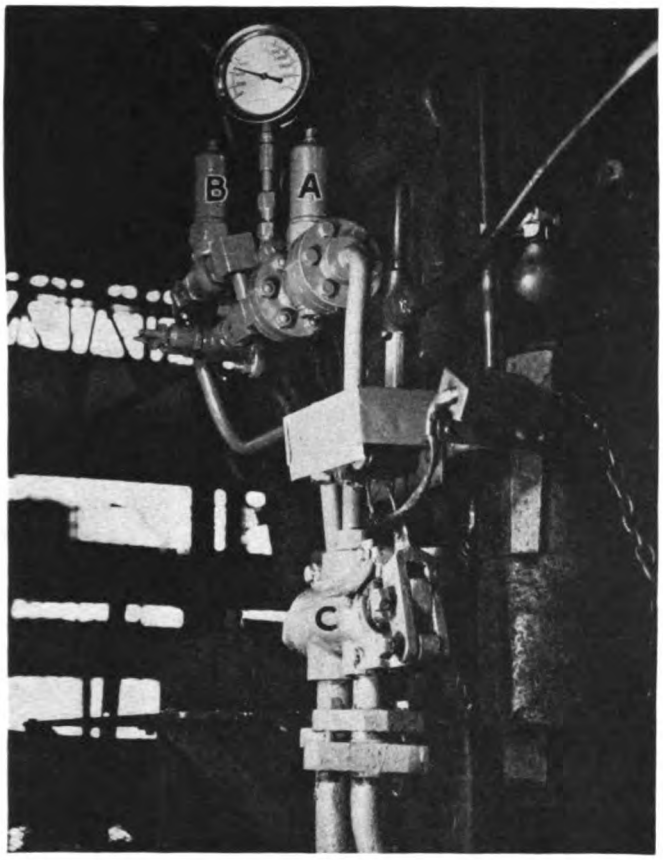


Fig. 6—Pressure-regulating and relief valves for hydraulic bull riveters

plus over basic diameters and that rivets be free of scale.

To further substantiate the importance of closer tolerances for rivets used in locomotive boilers, the following information on Super-True Tolerance rivets, published by the Champion Rivet Co., is quoted:

"The severe demands on vessels operating at elevated temperatures and pressures have developed a school of design in this type of construction. The joining surfaces of all parts entering these assemblies are machined to close limits. These parts are then pressed together in as tight construction as possible. Rivets used in this work must be equally perfect to insure uniform strength and long life. Super-True Tolerance rivets have been developed to meet requirements of this class of vessels and are superior to anything of their kind produced up to the present time.

"These rivets are accurate and straight within a few thousandths of an inch. Used in reamed holes and driven at a uniform pressure, they do not require caulking. The plates will not buckle or creep and in operation boilers will not develop caustic embrittlement in the riveted seams. Since a great deal of expense is involved in producing this type of rivet, extreme care should be used in driving them. A high grade heating forge of a semi-muffle type is desirable for this work. An indicating or controlling pyrometer is essential. After heating, scale should be removed by tumbling or with a wire brush, to insure a close metal-to-metal contact in the hole. These precautions may appear unnecessary, but results warrant their expense many times over in freedom from repairs and in continued long service."

Pressure Regulators for Bull Riveters

To better control tonnage on hydraulic riveters to that best suited for the various diameters of rivets, it is recommended that hydraulic bull riveters be equipped with regulating pressure and relief valves, as shown in Fig. 6. With such equipment, pressures can be regulated to give any assigned tonnage without requiring any change in the accumulator.

Investigation of results used with regard to tonnage for driving of rivets on hydraulic bull riveter indicates that there is considerable room for improvement from which we should benefit in our endeavor to overcome cracking of sheets from rivet holes. Today, and in the past little attention has been given to the excessive pressures used with the driving of rivets on hydraulic riveters. These pressures are very likely responsible for much of our trouble with cracks out of rivet holes. This can be noted from a study of the photograph in Fig. 5. The rivet marked *22* indicates that the rivet hole has been enlarged toward the caulking edge, and a series of such holes in the same rivet line will cause fractures in service. In the same view, rivets *23* and *24*, driven with correct tonnage, show rivet holes in perfect alignment.

Water Treatment

Water treatment has done much to prolong the life of steels used in present boilers. Modern water treatment properly controlled and maintained, by means of testing equipment provided for this purpose, has made it possible to keep the water heating surfaces of our boilers exceptionally clean and free from scale. By keeping these water heating surfaces clean there is nothing to prevent the ready transfer of heat from the fire side of the steel to the water without overheating of the steel which would otherwise occur.

Those of us who have had experience with modern high-capacity locomotives know how important it is to keep the firebox heating surfaces of these boilers free from scale. A very thin scale on these surfaces may cause severe cracking and other maintenance difficulties due to overheating of the steel. Firebox temperatures on these new locomotives must be very much higher than we have had to contend with in older locomotives as difficulty is experienced where only light deposits occur on the side sheets of these new engines. The same amount of deposit in older boilers would be ignored and the boilers pronounced "clean."

These experiences have made us more conscious than ever of boiler-water treatment and made us realize the value of maintaining the proper boiler-water conditions at all times. With boilers constructed in the best possible manner to prevent concentrated solutions from lodging between the plates at riveted seams, and with the research work being done by interested parties, we can feel confident that improvement will be made in the prevention of caustic embrittlement.

Boiler Maintenance

A locomotive boiler may be constructed in the best possible manner and of the finest material, but if not properly maintained in service it may give no better results than a poorly constructed boiler, and be a source of trouble not only from cracks from rivet holes, but boiler troubles in general. This is particularly true today with high-pressure and high-capacity boilers. It is essential that the closest attention be given to the preparation and issuing of instructions for blowing down, washing, and firing up locomotive boilers so as to reduce as far as possible the stresses due to expansion and contraction during these operations. Attention should also be given to proper lubrication and maintenance of sliding pads or shoes.

Recommended Action

It is the opinion of the committee that due to the importance of this topic particularly as regards the fabrica-

tion of alloy-steel sheets and the use of alloy rivets, this topic should be continued, and that a committee be appointed representing the locomotive builders and the railroads with a mechanical engineer or metallurgist to be selected by the Association to act as chairman. This is to be done with the approval of the Mechanical Division, Association of American Railroads. This proposed committee to report further on this subject at the 1941 meeting of the association with a view toward recommending a standard practice for the locomotive builders and railroads.

The report is signed by E. H. Heidel (chairman), general boiler foreman, C. M. St. P. & P., Milwaukee, Wis.; G. N. Wilson (vice-chairman), general boiler inspector, American Locomotive Company; Leonard C. Ruber, superintendent boiler department, Baldwin Locomotive Works; C. G. Mullenhour, superintendent of boiler department, Lima Locomotive Works; W. F. Moore; O. L. Pugh, mechanical and boiler inspector, D. T. & I., and A. F. Stiglmeier, general foreman boilermaker, New York Central, West Albany, N. Y.

Discussion

The discussion of this topic brought out the need for boiler shop equipment required to build boilers to the standards set forth in this report. One member stated that it is up to the master boilermakers to build boilers of such quality that they will enable the steam locomotive to meet successfully the competition of the Diesel.

F. K. Mitchell, assistant to general superintendent of motive power, N. Y. C., compared the building of boilers to the game of bowling. The final score in bowling, he said, depends upon the number of pins you knock down in each of ten frames. Similarly, the service we build into a boiler depends upon the design, selection of materials, laying out, heating and driving of rivets, and the workmanship. The final result depends upon the thoroughness with which each job is performed.

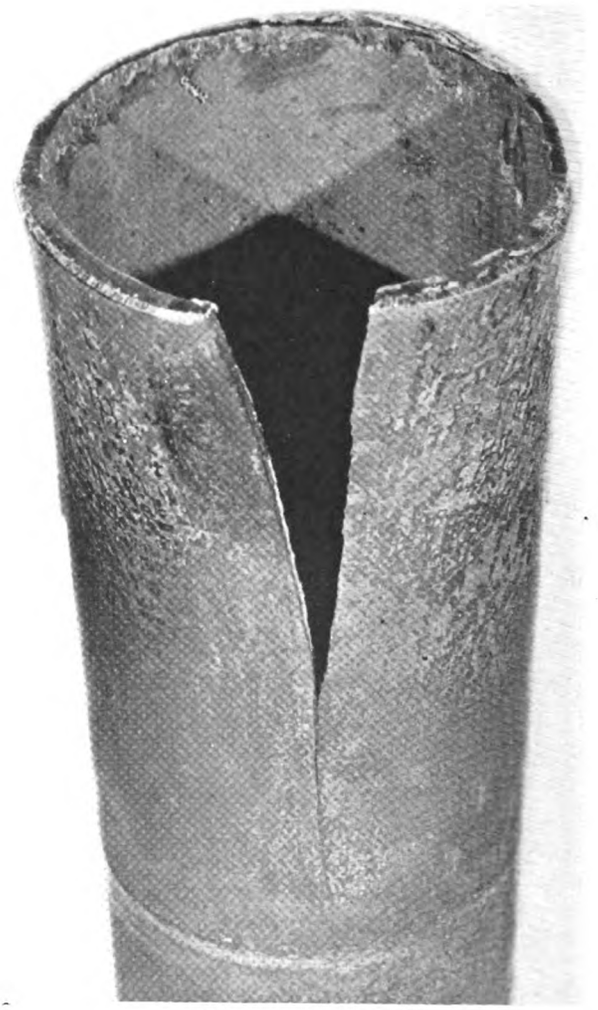
Flues Cracking Through Bead—Tube and Flue Application

In continuing the above subject from the 1939 proceedings, it is the general understanding that the primary cause for flue beads cracking in service is the welding of the flue bead to the sheet by the fusion weld method. The flue bead being restricted in its normal movement in addition to absorbing the shocks from expansion and contraction and the necessary working in application, it follows that the cracks appear in direct proportion to the amount of care or the lack of care given in the preparation and application of the flue or tube. From a study of the various questionnaires, it would appear from the varying number of gages of tubing used and the difference in amount of projection allowed for beads that each railroad is approaching the problem from a different angle. The least amount of material used consistent with strength and safety is the best rule.

While the method of application varies to some degree, it is more consistent than any other operation, as a large majority believe that copper ferrules should be used at the firebox end and the tube or flue ends should be a close fit. Just why a copper ferrule is necessary where the tube or flue end is eventually welded to seal it to the sheet, no one seems to know. Personally, we would prefer the no-copper-ferrule application, as the chance of a lamination or heating of the flue end is double where the flue or copper ferrule is liable to loosen up, forming a pocket between the ferrule and sheet or the ferrule and flue. In some cases where the copper ferrule was set with a sectional expander with a boss on the water end of the segments, it was noted that the copper ferrule had a tendency to bulge up in the center portion, leaving a minute air space between the ferrule and the sheet at the point of bearing. This bulging has also been noted under the bead where excessive material has been used for forming the bead. This condition, which constitutes a lamination, would certainly cause overheating, which, in turn, would cause the flue wall to split.

New material should be used for safe ending tubes and flues at the firebox end where the flues are to be welded to the sheet, as any reclaimed material used for this purpose will only aggravate the cracking condition. The use of reclaimed material, together with improper heating for swedging where the swedged material at the end of the flue is pinched or lapped over instead of drawn with the grain and then cut with a dull cutter or saw, and where little attention is given to the proper annealing or preparing of the flue ends for setting, presents a condition where a lot of cracked beads can be expected in service.

The fact that the flue bead is joined to the sheet by the fusion weld is undoubtedly the cause for the longitudinal cracking of the flue bead and the wall of the flue end into



Defective material

the water side of the sheet. Because this method does keep the flues tight, it would appear that it merits all of the attention and care that we can use in the preparation for the welding process. In the actual welding, consideration should be given to the kind and size of electrode to be used, so that the minimum of heat is required to make the weld as the actual fusion is done in a very restricted area. The proper amount of time for making the welds should not be sacrificed in the interest of shop output or piece work schedules.

There is no doubt that tube and flue material to accepted specifications will meet any range of temperatures set up in a firebox, providing the temperatures are raised and lowered in a reasonable time. When fires are dumped or water is changed to lower temperatures, and when blowers or other forced draft devices are being used, every care should be taken to protect against these rapid changes and thus avoid possible splitting of the flues and tubes, which have the least cross-section of any material exposed to firebox temperatures.

Recommendations

In line with a suggested change in policy this committee is offering the following recommendations, as developed from a comprehensive study of questionnaires sent out to the entire association membership: (1) Select material to known specifications; (2) hold the working of material to a minimum; (3) remove all mill scale and foreign material from fire end of flue and sheet; (4) do not use excess material in thickness or projection; (5) use proper tools for setting; (6) know that all grease, soap or dirt is removed where weld is to be applied; (7) use minimum of heat and the smallest practical electrode for welding; (8) use feedwater treatment when necessary to keep flues and sheets free from scale; (9) if flues indicate loosening at setting or develop minor leaks, tighten with a suitable expander, and (10) have welding done by a practical operator under competent supervision.

The report is signed by J. M. Stoner (chairman), supervisor of boilers, N. Y. C.; H. A. Bell (vice-chairman), general boiler inspector, C. B. & Q., Lincoln, Nebr.; L. J. Murray, general boiler foreman, W. M.; L. J. Johnson, Jr., boiler foreman, F. E. C.; H. M. Cooper, district boiler inspector, B. & O.; O. H. Kobernik, general boiler inspector, N. Y. C. & St. L.; S. M. Carroll, general boiler foreman, C. & O., and I. N. Moseley, master boilermaker, M. & W., Roanoke, Va.

Discussion

One speaker told of the experience that his railroad had with the flues on three locomotives. On the first locomotive, the welding of the flues had been done in the proper manner, the beads were snug, the radii of the flues had been belled evenly all around and the projection was $\frac{9}{32}$ in. for 3½-in. flues. All the flues on this locomotive were found in good condition after 240,000 miles.

In the second locomotive, the flues were not down against the plate, copper showed under the bead, and the flues had an excess projection of from $\frac{3}{8}$ to ½ in. After 100,000 miles, 50 per cent of the flues had to be removed from this boiler.

In the third locomotive, excessive heat appeared to have been used in welding the flues, the weld metal was not solid but seemed to be in the form of a shell. All these flues had to be re-welded after 10,000 miles.

An investigation of the cracking of the tubes and flues on another railroad showed that this cracking was the result of other causes besides welding. The cracked flues were found to have the correct physical and chemical characteristics. However, the cold working of these flues had ruptured the structure and produced cleavage planes. The expansion and contraction of the boiler in service that caused the flues to open up at these cleavage planes. It was concluded that the excessive hammer blows in caulking the beads was the primary cause for the tubes and flues cracking.

It was brought out in the discussion that there was no set rule to follow for the elimination or application of copper ferrules when applying flues. One railroad experienced more fire cracking of the flues when the ferrules were eliminated. Another railroad had applied the flues by welding without ferrules and these applications had operated for 42 months without a cracked bead.

Cinder Cutting of Firebox Sheets, Flues, Tubes and Smokeboxes

Cinder cutting is not a new problem. It has been with us in some form or another ever since the beginning of coal-burning locomotives. In the early stages this was entirely in the front end appurtenances such as the exhaust base and steam pipes. Later on, with the advent of spark arresters, the abrasive action took place at the smokebox ring, smokebox front and the netting.

When superheaters were adopted, the front end was still the only part of the locomotive boiler affected, except the superheater pipes and unit shields. Shortly afterwards, locomotive stokers were introduced. During the first ten years or so with the superheater and stoker, no changes in cinder cutting were noted. All this information indicates that up to that time nothing serious had happened. So, in discussing cinder cutting, we should bear in mind that the real start of this problem coincided with the change in operating conditions on railroads. Three factors, speed, tonnage and mileage, have increased without proper regard for the relationship which should exist between the firebox, grate area, ash-pan air openings, front end and flue area.

With the demand for high boiler capacity the firing rate has had to be increased, causing the unburned coal to pass along with the gases. How terrific this gas velocity can be when imparted to the gases and cinders is shown in C. A. Brandt's paper on the locomotive boiler.* In his paper Mr. Brandt analyzed test figures on the Pennsylvania MIA locomotive No. 6706. He determined the gas velocity through the flues near the back flue sheet to be as high as 204 m. p. h., and between the top of the arch and the crown sheet as high as 260 m. p. h. This high velocity of the combustion gases causes cinders to be picked up and carried with the gases. It results in an abrasive action such as shown in Figs. 1 and 2.

Fig. 1 shows a flue seriously affected by cinder cutting at the inside of flue. The shaded portion is worn thin and finally breaks through, causing delays and failures. Fig. 2 shows staybolts and crownbolts as they look after this action has taken place. All of these bolts have to be removed and renewed. A check shows no difference in arch-tube or syphon-equipped locomotives.

An article by F. P. Roesch, vice president, Standard

* An abstract of this paper, presented at the 1939 annual meeting of The American Society of Mechanical Engineers in Philadelphia, Pa., appeared in the January and February, 1940, issues of the *Railway Mechanical Engineer*.

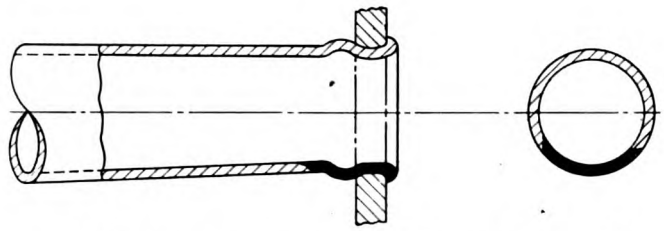


Fig. 1—Shaded area is part of flue or tube seriously affected by cinder cutting

Stoker Company, states some facts that should be taken into consideration: "Present day locomotives are designed to burn between 80 and 120 lb. of coal per sq. ft. of grate area. Taking the mean, or 100 lb. of coal per sq. ft. of grate per hr. as an average and assuming the locomotive has 80 sq. ft. of grate area, we have an average consumption of 8,000 lb. of coal per hr. Inasmuch as 260 cu. ft. of air is required to burn one pound of coal, it follows that, to burn 8,000 lb. of coal, 2,080,000 cu. ft. of air must be supplied, and all this air must come in through the openings in the ashpan. If, therefore, the area of such openings is sufficient to maintain atmospheric pressure under the grates, i. e., in the ashpan, the velocity of air flowing into the ashpan is relatively low, but if such openings are restricted, the velocity will increase in proportion to the restriction.

"It must be understood that we have what might be termed two forces to consider. First, the creation of vacuum in the firebox, which is accomplished in the front end through the action of the exhaust-steam jet discharged from the nozzle. The vacuum so created must be filled from the rear. Therefore, the vacuum extends to the firebox, creating what we usually term a pulling action. On the other hand, to supply that vacuum, air must be forced up through the firebed by the pressure in the ashpan. A rule of thumb commonly

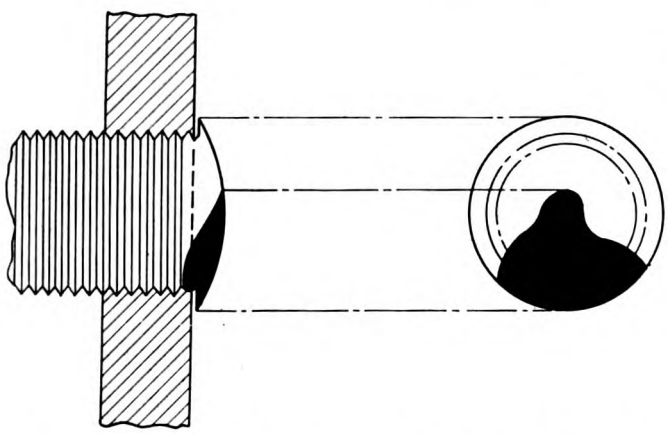


Fig. 2—Shaded area shows part of staybolt or crown-bolt head affected by cinder cutting

used and found approximately or slightly in excess of 14 per cent of the total grate area, atmospheric pressure will be maintained in the ashpan. If the opening is less than 14 per cent a higher vacuum is required in the firebox.

"From all this it will be noted that in order to reduce cinder cutting and honeycombing, we must begin at the source, the ashpan, through the grates and firebox until we get to the front end. All these factors being intimately related to one another, any neglect of one affects cinder cutting and honeycombing, correspondingly."

In studying all the data available, nothing has been found that will entirely overcome cinder cutting under present operating conditions. It is worth while studying the various remedies recommended, which will apply to various conditions.

One of the most common remedies is the baffle brick arch shown in Fig. 3. It prolongs the life of flue and also helps prevent honeycombing. Details of these baffles can be obtained from any of the brick-arch man-

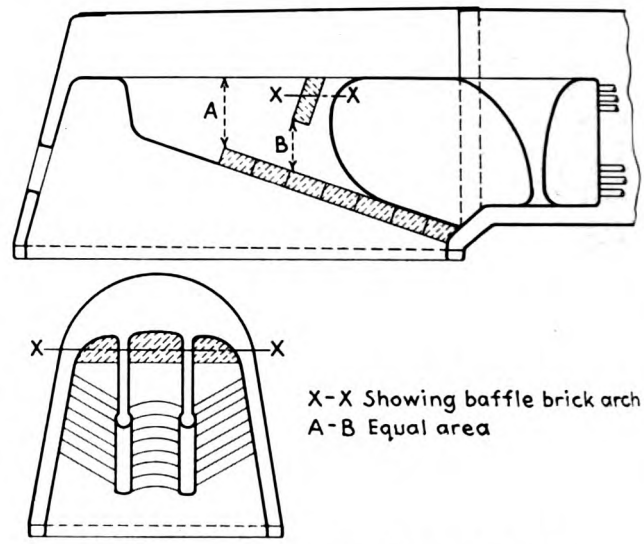


Fig. 3—Application of baffle brick arch to firebox

ufacturers. On one railroad prior to the application of baffle brick, flues which had been in service for about 18,000 miles started to show leakage at some point in the flue sheet. With the baffle brick the flues stay in service nearly 48,000 miles. On certain types of locomotives this baffle brick will also prolong the life of crown bolts and staybolts. As the highest gas velocity is reached over the top of the arch by retarding the flow at this location the cinders have less abrasive action.

The welding of a bead in front of crown bolts and staybolts as shown in Fig. 4 has also proved to be successful, as it will shield the bolt head. Several questions have been raised however on this practice which we believe should be brought to your attention. One of these is whether or not we can with safety continue to reweld this bead in the same place without causing the sheet to crack. This is a problem that should be given some study as we know that continuous welding of metal at a given point will eventually crack open in the undercut of the weld. Several designs of thimbles have been tried out, and good results are noted.

The latest development to increase the life of the flue

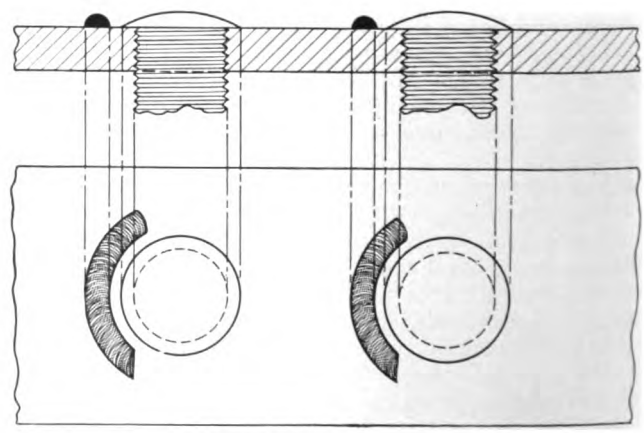


Fig. 4—Bull head protected by welded bead

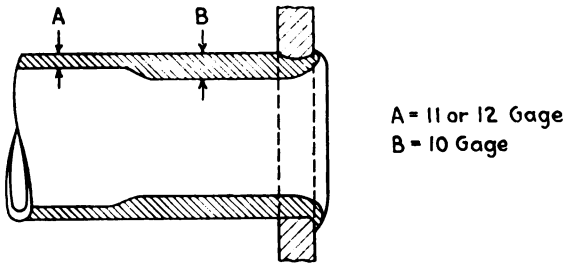


Fig. 5—Flue end thickness increased at the back flue sheet

seems to be a development in the right direction and Fig. 5 shows a flue of that design. Questionnaires have indicated that a tube greater in thickness will outlast a flue of lesser thickness, although both are in the same location, and it also brings out the fact that if a thimble will prolong the life a heavier-gage flue will do the same thing. As you may note in Fig. 5, the flue shows a 12 or 11 gage up to within 18 in. of the back flue sheet where it is increased to a 10 or 9 gage. The reason for this short end is that the flue, if it were increased, would present a problem of weight.

The various designs of baffle plates used in front ends are too numerous to mention, but we know that many of them assist in reducing the cost of repairs to original sheets in smoke boxes. A unique device to by-pass the exhaust steam is being tried but we are unable at this time to give details. There is also the front distribution stoker in which one railroad has been very much interested, and their representative at this meeting should be able to give some very good information in regard to this topic. Duplex syphons and Circulators make some claims on cinder cutting but from information on questionnaires received there is no difference noted when these devices are used.

It is with great anxiety we observe the havoc caused to firebox sheets and attachments by forcing a locomotive boiler beyond its capacity. There is no doubt that our boiler troubles are increased by higher tonnage, speed and mileage, causing cinder cutting and a high cost of boiler maintenance. We should bear in mind that a locomotive boiler is a power plant on wheels. It is recommended that in designing future locomotives, the boiler be given more attention with respect to obtaining the correct relation of capacity to demand.

The report is signed by S. Christopherson (chairman), supervisor of boiler inspection and maintenance, N. Y., N. H. & H., New Haven, Conn.; M. C. France (vice-chairman), general boiler foreman, C. St. P., M. & O., St. Paul, Minn.; W. Freischleg, general boiler foreman, Wabash; V. H. Dunford, general master boilermaker, S. A. L., Norfolk, Va., and E. J. Brennan, general boiler foreman, B. & M.

Discussion

In the discussion Chairman Christopherson gave some additional data, as obtained from questionnaires, to show the effect of tonnage, speed and length of run on cinder cutting. On those roads experiencing no cinder cutting on freight locomotives, the average tonnage was 2,900, the speed 33 m. p. h., and miles per trip 248. On the railroads which had cinder cutting, the average tonnage was 5,200, speed 47 m. p. h. and miles per trip 424. For passenger locomotives where no cinder cutting was obtained, the average train was 11 cars, the speed 50 m. p. h., and the miles per trip 449. Where cinder cutting occurred the average train was 14 cars, the speed 63 m. p. h., and the miles per trip 622.

Another railroad had found that the kind of coal affected the cutting action of the cinders. One coal with 30 per cent ash had a considerably greater abrasive action than the other coals used. On another railroad which had tried the front-delivery stoker, tests had showed that about 50 per cent less cinders were obtained as compared with the back-end stoker.

Maintenance of Tender Cisterns

The capacity of tenders during the past ten years have increased considerably due to the increased length of runs, elimination of intermediate stops because of water conditions and the demands for higher speed. The fuel capacity has increased from 15 to 25 tons, water capacity from 10,000 to 25,000 gallons and weights have increased accordingly. From the results of questionnaires we find that the rectangular-type cisterns are used extensively on all roads. Only 40 per cent have had any experience with the Vanderbilt or semi-Vanderbilt types.

Rectangular-Type Cisterns

In considering the maintenance of cisterns we will first discuss the rectangular type. On the built-up type cisterns we should see that floor boards are of proper length and spaced so that each one will support its part of the load. At times, when short boards are applied, we find cracks and leaks in the bottom sheet due to overhang at this location. On the built-up rectangular cisterns we find that the vertical, staggered splash plates or bracing are used more than any other type of bracing. Heavy tee or angle irons are stagger riveted to the sides, top and bottom of sheets and ⅜-in. to ½-in. splash plates are riveted to these supports. Each cistern should be built with a sufficient number of splash plates to minimize the surge of water, the size and number depending on construction.

In addition to the vertical bracing mentioned above some roads use what is called the box-type bracing, that is, vertical bracing extending the full width of the cistern and riveted to tee irons on the sides, top and bottom with a longitudinal center support riveted to angle irons attached to the vertical sheets. With this arrangement boxes are formed on the right and left sides of the cistern and suitable holes are cut in the vertical plates to permit the free movement of water through each section.

The vertical or box-type bracing requires less maintenance than the horizontal or cross-bracing in that braces do not sag and pull rivets loose from horizontal tee or angle irons and are more accessible for cleaning. Also, this bracing keeps the water in smaller units, thus eliminating the sudden surge of water when making stops. In some cases the edges of the vertical splash plates are flanged at the sides, top and bottom, eliminating additional rivets for tee or angle irons. On the older type of built-up rectangular cisterns where the bottoms and sides were originally riveted to angle irons we find ½-in. sheets with sides and ends flanged upward are used for renewals. The sheets are riveted at the top of the flange, thus eliminating rivets at the bottom of the sheet, a continual source of leakage.

Some roads report that they are using successfully corrugated vertical splash plates. The corrugations, similar to those in freight-car sheets, are formed on a hydraulic press and are 20 in. wide, riveted at the top and bottom. When cracks develop at the sides of a cistern we find that for appearance flush electric-welded

(*Continued on page* 508)



A. J. Krueger,
Vice-President



E. S. Smith,
Vice-President



F. E. Cheshire,
Vice-President

Annual Meeting of

Car Officers' Association



J. S. Acworth, President

Work during the past year commended in addresses by four railway executives—Nine standing reports are presented

THE annual meeting of the Car Department Officers' Association, held October 22-25, inclusive, at the Hotel Sherman, Chicago, was notable perhaps primarily for the recognition accorded the association, as well as the achievements of car-department forces in general, by four well-known railway executive and mechanical officers. These men included J. M. Symes, general manager, Western lines, Pennsylvania; O. A. Garber, chief mechanical officer, Missouri Pacific; D. S. Ellis, chief mechanical officer, Chesapeake & Ohio, and D. J. Sheehan, superintendent of motive power, Chicago & Eastern Illinois.

Mr. Symes said that car department forces have been an important factor in past improvements in railway service and will no doubt contribute substantially to future improvements. Mr. Garber said that improved methods in the maintenance of freight and passenger cars are required to an ever-increasing degree in rail transportation and that the Car Department Officers' Association must assist, as it has in the past, in developing efficient, dependable methods and practices.

Mr. Ellis said that on car department forces falls the major responsibility for meeting the most difficult problem confronting the railroads, namely, to supply shippers with the many different kinds of freight cars they now demand, in satisfactory condition to carry loads safely to destination. He urged the making of thorough periodical repairs to freight cars to keep them off the rip track and, in paying tribute to the present association and its first president, K. F. Nystrom, mechanical assistant to chief operating officer, Chicago, Milwaukee, St. Paul & Pacific. Mr. Symes suggested that attendance at the annual meetings would be greatly augmented if individual members who desire to come would only indicate that desire to their superiors and explain what information or other benefits they expect to derive.

Mr. Sheehan said that under present conditions, the railroads must use every effort to keep trains moving and



G. R. Anderson,
Vice-President



F. L. Kartheiser,
Secretary-Treasurer

the function of car-department officers in promoting improved transportation is to eliminate as far as possible all delays which might in any way be chargeable to car-department forces. As chairman of one of the committees of the association, Mr. Sheehan presented in some detail suggestions regarding maintenance practices designed to insure more reliable and economical operation of freight cars.

The association was also addressed by Roy V. Wright, editor, *Railway Mechanical Engineer,* who congratulated the association on its achievements to date and said that they are sure to attract the favorable attention of railway executives throughout the country. He called attention to the fact that experienced mechanics are being offered attractive inducements to leave the railway service so railroads must face the problem of training new employees if they expect to get the kind of help required for intensive maintenance programs now under way. Mr. Wright also referred to the appointment of new supervisors who are thoroughly familiar with mechanical details of the work to be done but may need special training of special instructions in what is really the most important part of their work, namely, the supervision of men.

Committee reports presented at the annual meeting were in general constructive and informative. In addition to the membership committee reports by the four vice-presidents of the association and the report of the Secretary-Treasurer, F. L. Kartheiser, chief clerk-mechanical, Chicago, Burlington & Quincy, standing committee reports on the following subjects were presented by their respective committee chairmen: Freight Car Maintenance, D. J. Sheehan, superintendent of motive power, C. & E. I.; Shop Operation, Facilities and Tools —Welding, J. A. Deppe, superintendent car department, C. M. St. P. & P.; Passenger-Car Terminal Handling—Air-Conditioning, E. J. Hollahan, general car foreman, I. C.; Lubricants and Lubrication, J. R. Brooks, supervisor of lubrication and supplies, C. & O.; Freight-Car Inspection and Preparation for Commodity Loading, F. J. Swanson, general car department supervisor, C. M. St. P. & P.; Interchange and Billing for Car Repairs, M. E. Fitzgerald, master car builder, C. & E. I., and D. E. Bell, A. A. R. instructor, C. N.; A. A. R. Loading Rules, H. H. Golden, supervisor of A. A. R. Interchange and Accounting, L. & N.; Painting, C. L. Swing, general foreman, Pullman-Standard Car Manufacturing Company; Publicity, E. L. Woodward, western editor, *Railway Mechanical Engineer.*

The sessions of the 1940 annual meeting of the Car Department Officers' Association were presided over by President J. S. Acworth, supervisor of equipment, General American Transportation Corporation, who described the activities of the association during the past year in his presidential address. The total registration of railroad men at the meeting was 300, although a considerable number of railway car men who did not register are known to have attended the meeting. The outstanding event of the meeting, from the point of view of improved acquaintance and good fellowship was the annual dinner, attended by 1,160 members and guests of the association. Arrangements for this dinner were made under the general direction of J. M. Brophy, superintendent car department, Illinois Central.

Election of Officers

On the last day of the convention the following officers were elected for the ensuing year: President, A. J. Krueger, superintendent car department, New York, Chicago & St. Louis, Cleveland, Ohio; vice-president, E. S. Smith, master car builder, Florida East Coast, St. Augustine, Fla.; vice-president, F. E. Cheshire, general car inspector, Missouri Pacific, St. Louis, Mo.; vice-president, G. R. Andersen, district supervisor car maintenance, Chicago & North Western, Chicago; vice-president, J. M. Brophy, superintendent car department, Illinois Central, Chicago; secretary-treasurer, F. L. Kartheiser, chief clerk-mechanical, Chicago, Burlington & Quincy, Chicago.

The Board of Directors includes: J. S. Acworth, supervisor of equipment, General American Transportation Corporation, Chicago; P. P. Barthelemy, master car builder, Great Northern, St. Paul, Minn.; W. A. Bender, master car builder, Alton, Chicago; C. Claudy, master car builder, Grand Trunk Western, Battle Creek, Mich.; J. A. Deppe, superintendent car department, Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis.; J. W. Fogg, vice-president, MacLean-Fogg Lock Nut Co., Chicago; L. H. Gillick, assistant to vice-president, Vapor Car Heating Company, Chicago; H. H. Golden, supervisor A. A. R. Interchange and Accounting, Louisville & Nashville, Louisville, Ky.; E. B. Hall, chief mechanical officer, Chicago & North Western, Chicago; J. E. Keegan, chief car inspector, Pennsylvania, Chicago; G. E. McCoy, assistant general superintendent motive power and equipment, C. N., Toronto, Ont.; J. P. Morris, general mechanical assistant, Atchison, Topeka & Santa Fe, Chicago; C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau, Chicago; J. J. Root, Jr., assistant to vice-president, Union Tank Car Company, Chicago; C. E. Strain, superintendent car department, Pere Marquette, Grand Rapids, Mich.; S. O. Taylor, master car builder, Missouri Pacific, St. Louis, Mo.; H. H. Urbach, mechanical assistant to executive vice-president, Chicago, Burlington & Quincy, Chicago; and E. M. Wilcox, assistant superintendent of equipment, New York Central, Chicago.

Importance of the Car Department in Rail Transportation

By J. M. Symes,

General Manager, Western Lines, Pennsylvania

[Mr. Symes reviewed briefly recent railroad history showing how the expenditure of one billion dollars in 1923 and slightly less during each of the next eight years for improved equipment and facilities enabled the railroads to handle the peak traffic of 1929 with the greatest efficiency ever attained. Subsequently, in a depression period, with little capital to invest and living more or less on their "fat," at least as regards equipment condition, the roads also have rendered excellent service. The latter part of Mr. Symes' address is quoted in the following paragraphs.—EDITOR.]

Summing up what I have said, the billions of dollars that were spent in capital improvements together with other improvements in the art of transportation have, in the short period of 15 years, resulted in the railroads' being able to handle trains 18 per cent heavier, 50 per cent faster, with 20 per cent less fuel, causing a reduction in transportation expenses of five hundred million dollars a year. The reductions obtained by increased operating efficiency have been more than passed on to the shippers in the way of lower rates; in other words, we have been able to give a better service to the public

at lower rates than ever before, which has enabled us to at least partially meet our subsidized competition. Had we not been able to do this the volume of traffic now being handled by the railroads would be much less today. Improving the service and reducing costs is the problem of every railroad officer. A real accomplishment has been made during the past 15 years and the car department has been just as much responsible for it as any other department on the railroad. We are a long way off from "peak efficiency" and even greater progress will be expected of all of us during the next 15 years.

Car Forces in the Front Line of Railway Progress

The car department will have to be in the front line in this parade of progress. It will be expected to contribute substantially in solving railroad problems and should be constantly thinking about it. A few of the problems that will confront us are: (1) The railroads must be able to keep their car-mile earnings up if they are going to be a successful transportation agency. This might in some cases mean a premium in the way of certain rate reductions. The car department should be figuring ways and means of providing the proper kind of cars to bring this about. (2) The railroads must maintain and improve their train load and haul more revenue tons per train. This will be partially accomplished by reducing the ratio of non-revenue load to pay load without in any way sacrificing safety. Considerable has been accomplished in this direction but much remains to be done. (3) Average freight-train speed will have to be increased. Remarkable progress has been made in this direction and many freight trains are now operating at speeds of 60 m. p. h. but the 1939 average of 16.7 m. p. h., after all, is not very fast. Elimination of delays to trains by reason of car failures en route will help improve this situation. (4) Varying types of equipment will have to be provided to meet the varying demands of shippers for the transportation of particular commodities. At the same time the railroads will have to guard against the creation of so many different types of cars because usually they are one-way cars and 50 per cent of their mileage is empty—not a healthy situation. Traffic, transportation and car-department officers will have to cooperate closely and bring forth more "all purpose" cars, taking care of shippers' requirements, yet keeping empty mileage to the minimum. (5) Greater use will have to be made of freight cars. An average of 31.7 miles per car per day is not very good. Fifteen car-days for each car loaded in the United States will have to be bettered. When cars are needed they can earn nearly $7 per day for the railroads on a 15-day turn-around. If this time could be cut to 10 days, and I venture the opinion that it will within the next 10 years, the railroads could earn nearly $10 per car per day and handle the business with one-third less equipment. We are going to have to persuade shippers to cut down on the loading and unloading time; increased freight-train speeds; eliminate terminal delays; eliminate car failures on the road; put cars through the shop faster and have them come out better—improved maintenance and shop practices will go a long way in accomplishing this. (6) The railroads will have to have equality of treatment with their subsidized competition. We do not want subsidy because we believe that all transportation agencies should pay their way. While the recent passage of the transportation bill does little for the railroad industry, nevertheless it is recognition on the part of government that there is a railroad problem and the creation of the board that is to study the transportation problem might lead to the real answer to it. Public opinion is usually slow in recognizing certain situations but, once recognized, action is taken to correct it. You can do a lot for the railroad industry by keeping the public properly informed as to the true railroad problem.

As to the future of the railroads, it is evident, therefore, that they must get more business by rendering a better service, increase operating efficiency by reducing costs, and get a "square deal" when the transportation policy of this country is finally determined. The railroads have but one product to sell—transportation. Their entire revenue is secured from the movement of cars—both freight and passenger. Car-department forces have been largely responsible for past improvements; of necessity, they will have to be responsible for a major part of future improvements. I know they are capable of living up to their responsibility and will come through as expected.

Car Maintenance, Performance and Expense

By O. A. Garber

Chief Mechanical Officer, Missouri Pacific

New methods in the maintenance of freight and passenger cars are required to an ever increasing degree in rail transportation. Train delays due to car failures, revenue-bearing shipments delayed on account of bad-order equipment, and the time equipment is held out of service for repairs affect performance and represent expense, and so demand competent analysis and efficient correction.

Because on-time train performance and net income are to a high degree dependent upon car maintenance practices, I believe my discussion with you should look toward standards of dependable and economical methods and practices. Since we learn largely by doing, it is evident that the best thing to do is to determine how others do it, and from the collected methods select those most productive of efficient operation. It is my belief that such action should be a primary purpose of this association—development of efficient and dependable methods and practices. Unless our association can meet this challenge for improvement the need for it is questionable.

Past Experience, the Basis of Future Improvement

In the progress of industry, as in the common occurrences of life, we are liable to forget the ground we have traveled over, and frequently fail to gather experience as we go. It is in the interest of advancement that we should not lose the knowledge we have gained from experience, and upon which must be planned the accomplishments of tomorrow. Without knowing how it was done yesterday we cannot improve today's performance, nor plan well to better meet the tasks to be done tomorrow. Abrupt conclusions must not be drawn from single facts. On the contrary, all of the facts of experience must be made available so that the design of the necessary improvement in car maintenance practices will be substantially supported.

Those of us who have been in this game for many years have an obligation to the industry and to the younger men of this association. It is to make available to all the benefit of our collective experience. Such a task is not simple, but we must remember that whatever is obtained cheaply is worth just what it cost.

Our membership includes many outstanding car men and supervisors who are in daily contact with car-department operation. It rests with us—our leadership and the association as a whole—to know that these problems are recognized and acknowledged. Further, that constructive, convincing, conclusive steps be taken and followed diligently, to the end that the better methods, the more productive and economical practices be established as operating standards, that uniformity in train and car inspection, car classification for loading, and repair and interchange practices be attained, and that car maintenance expense in all of its phases be reduced to economic control. Mere evidence of certain things as desirable is not enough. It is our job to provide the method, outline the procedure and produce the necessary follow-up. We must recognize that our failure to see the way in which car maintenance and performance fit into the whole scheme of transportation is dangerous inefficiency.

The car-department organization must be able to justify its operations in terms of expense—in the language of the accountant—investment and return. Railroading is a business, and to see only the technical side and not the broad business relationships is to reduce the efficiency accordingly. The policies that guide car maintenance should be based primarily on money consideration. To be a good technician is not sufficient. The qualities of a good manager are also required. This management problem involves the prime cost factors of material and labor.

As concerns material costs of car maintenance, it is our job to assure that maximum dependable service life is obtained from all materials, and to see that such materials are not removed from service by technical or arbitrary interpretations of rules. Training of the personnel must instill a sense of individual responsibility for the exercise of experienced judgment. Mere finding of a defect is by no means sufficient. This trained exercise of judgment must be such as will assure the maximum return on the expenditure for materials. The higher speeds, faster acceleration and more rapid deceleration, with their consequent severe brake action, present new problems and impose greater requirements on materials. None of these justifies that materials be condemned short of maximum dependable service life.

It is frequently possible to use a better material, employ improved methods of application and produce longer dependable service life with a consequent lower final cost. To accomplish this desirable end it is necessary to have full information on the performance of materials in current service in terms of average service life, and the tendencies of material failures. Obviously, this assumes the ability of the men in the field to judge accurately materials and materials' service life. We, therefore, come to the fundamental requirement of adequate, all-inclusive training of labor—the workman, the foreman and the general supervisor. Here rises the problem of labor management.

Management of labor means all that the word implies and not simply and primarily the appointment of supervisors and "bossing" of the job, or the hiring and firing of men. It must include careful selection, proper assignment and thorough and continuous training of every member of the organization, from the messenger, through the rank and file to the department head.

For economy in operation, labor saving is not only desirable but imperative. The reason for labor saving is not to get rid of men, but to determine which processes or operations can be turned over to machines and which can be simplified so that each man can accomplish more. Because labor saving makes men more valuable, even a low-wage man is too expensive to employ in pushing a truck.

The final aim in the management of labor should be to create from the numerous individuals, variously gifted, including those with limited training, a completely co-ordinated organization, advancing along well-defined ways toward improved train performance and reduced maintenance expense. In this matter of labor management it is necessary to apply at least the same amount of common sense toward maintaining the worker as is applied to the maintenance of machines and equipment.

Public education has not kept pace in providing the individual with the full knowledge necessary to cope with the problems of present-day labor management. It is, therefore, becoming more evident that each individual must be taught his particular responsibilities in this requirement for fast, dependable, economical transportation and be trained to stand up to them. It should be apparent that this training problem cannot be solved by the individual, be he workman, foreman or general supervisor. It is one of which this association should courageously strive for the practical solution, if we are to reach the desirable objectives.

Loyalty and high morale can be secured only through encouragement, right discipline and human understanding from the men to whom the rank and file look for leadership. Loyalty cannot be commanded but can only be developed through fair dealings and right objectives.

The full success of an organization depends upon the development of the highest skill in each of the individual members. No objectives could be higher than that we assume a trusteeship for the growth, well-being and contentment of all those who look to us for leadership. No accomplishment can be more dignified than a contribution to the solution of the problems of human relationships.

Then, in the final analysis, car maintenance, performance and expense depend upon the collective effort we make to better train and direct the car men of this great industry in providing more economical transportation, constantly made more dependable.

Shop Operation—Electric Welding

In submitting this report, it has not been the intention of the committee to present a technical thesis which has been adequately accomplished by the American Welding Society in its Welding Handbook and by numerous other technical publications. Instead, the committee has confined its report to certain aspects of electric welding that relate more particularly to our own railroad problems.

Recommendation of Revision of Rule 23 of the A. A. R. Code of Rules

This rule was made effective November 1, 1920, and

its requirements have not been seriously changed since that time. Few will deny that the art of welding has progressed remarkably during the past twenty years, and it is only in keeping with good practice that this rule be, as far as possible, brought up to date. It is the earnest suggestion of this committee, therefore, that the A. A. R. give serious thought to the following:

(a) Elimination from Sec. II of brakestaffs, sill steps and supports, uncoupling levers and ladder sides and their supports. No reason can be seen by the committee why these cannot be welded without fear of hazard.

(b) The sentence in Sec. II reading: "Top chord angles of open-top all-steel cars if the fracture is located at a point between bolsters more than five feet from the center line of either body bolster", should be eliminated as there is no reason why successful welding of these angles cannot be done at any location.

(c) Revision of percentages in footnotes in Sec. III. We believe that much lower figures are practical.

(d) Omission of Nos. 1 and 5, Spring Planks, Sec. IV. We see no reason for any such restriction.

(e) Elimination of No. 2, Spring Planks, Sec. IV. We believe that all spring planks should be removed prior to welding, regardless of the location of the crack or fracture, and perhaps the caption to the paragraph should so state.

(f) Revision of Figs. 1, 2, 3 and 4. These were obviously based on welding with bare rods. Today the latter are being used much less frequently and with the advent of the coated electrode now generally used, new specifications should apply.

(g) Elimination of the specific temperature readings in (e) of Sec. V, namely, 1,400 or 1,500 deg. F. We believe that these temperatures should be set by the individual metallurgists or other qualified persons since the temperatures to be used depend upon the composition of the part that is to be annealed. A chart should be set up for the different metals.

The above suggestions do not pretend to show a comprehensive analysis of Rule 23. The committee merely wishes to stress the urgency of bringing it more nearly up to date and if the A. A. R. deems it expedient to do so, it will undoubtedly be guided by a closer technical analysis.

Operator Qualification

In electric welding competent and skillful operators are essential. In railroad work, where the piece welded usually does not allow for more than a visual inspection of the weld, the operator becomes the inspector. From this it will be appreciated how important it is to have competent, conscientious operators. Note, however, that this does not preclude the necessity of having trained inspectors, who not only inspect the product, but also keep in constant touch with the progress of each operator.

When the art of welding was in its early stages, men drifted into it and after years of experience became fairly proficient. Welding jobs were then few and far between. Today, however, where cars are often entirely welded, no railroad can afford to gamble on haphazard workmanship. Each man should be tried and tested before being hired as a welder and this can only be accomplished by qualification tests.

Some railroads already have practical methods of testing welding operators and do so periodically to determine their progress. The American Welding Society has set up standard qualification tests for welders and these may be modified or accepted by adhering to essentials as each railroad sees fit.

Too much stress cannot be laid on instruction of operators. Ability to make a good bead is not necessarily the criterion of a good welder. He should have some knowledge of metallurgy and stress analysis, and the transmission of this information should be the responsibility of the welding engineer and his assistants. Experience has shown that the majority of welding operators are anxious to increase their knowledge on the art of welding. Saturday morning classes have been inaugurated on some railroads and the men attend on their own time. This arrangement has proved most successful. Questions are freely discussed and much benefit of a mutual nature results.

Cost Reduction by Means of Jigs, Choice of Electrodes, etc.

The most efficient method of deposition is downhand. Vertical and overhead welding, on the other hand, require more skill and are more costly methods of depositing weld metal. It should be the aim of every welding supervisor, therefore, to arrange as much of his work as will allow downhand welding. This can be done by suitable jigs. There are a number of these, the most popular being the barbecue or spit. It can take any shape and can be revolved as the particular job requires it. On new car construction, it is ideal for welding bolsters, cross-bearers and end-sill assemblies.

The process of building up brake heads also lends itself to jig work. The jig can be built to rotate in a horizontal plane and accommodate as many as a score of brake heads at one time. This reduces set-up time and eliminates needless motion on the part of the operator.

When engaged in the reclamation of journal-box lids, brake heads, couplers, spring planks, etc., the car-department supervision will find it more economical to keep a definite force on this work. Very often, welders on the schedule repair tracks are called upon to do this reclamation work, but this is not conducive to the best results.

Insignificant though it may seem, choice of the correct electrode has a definite bearing on cost. Where fit-up is poor, a straight polarity rod should be used. On the same job a reverse polarity rod would take much longer and would not make as satisfactory a weld. Where fit-up is good and penetration is required, a reverse polarity rod is ideal. The larger the diameter of the electrode, the cheaper is the deposited metal. Hence where single-pass welding is called for, the cheaper job is accomplished by a large electrode.

Machine Maintenance

It is very important that welding machines receive periodic inspection. The following suggestions may serve to achieve the best results:

a—Blow out machine with air once a week.

b—Check brushes weekly and adjust or replace if necessary.

c—Check lubrication weekly and add grease or oil where needed.

d—Wash bearings annually with carbon tetrachloride and regrease. Use special short fiber soap grease only. Lime soap grease will ruin the bearings.

e—When machine fails and requires repairs, use this opportunity to overhaul completely: (1)—turn down commutator and undercut between segments; (2)—reinsulate coils; (3)—wash out and inspect bearings and replace if necessary; (4)—break all connections, clean and reconnect; (5)—install new brushes and check tension in springs.

When serious cracks are to be welded, it is poor practice to do so before veeing them out. This allows for maximum penetration. In most cases it is practical to vee out by means of the acetylene torch. Where bad cases of corroded sections exist, it is essential to clean these thoroughly prior to welding.

The problem of warping often arises and where this is likely to prove serious, clamping jigs should be used.

There is little need to emphasize the fact that welding produces locked-up stresses and the quickest way to get rid of these is by annealing. Naturally in many instances, this is impossible. When stresses are likely to create difficulties and annealing cannot be accomplished, then care should be taken to deposit the welded metal in such a way as to reduce these stresses to a minimum.

Welding in Relation to Reclamation and Repairs

Welding has been a boon to railroads in the reclamation of worn or broken parts. Such items as worn or cracked cast-steel truck sides and bolsters, have been profitably reclaimed by means of welding without any mechanical difficulties.

On passenger cars, riveted type sides, ends and roofs that are worn, have been replaced in part or whole by welded sections with completely satisfactory results. Vestibule and baggage side doors, ventilators, inside trim and many other parts have likewise been profitably subjected to welding. On freight cars reinforcements have been developed for strengthening posts and braces, bolster and center plate connections and other parts of the underframe and superstructure.

In all these cases of repairs by means of the electric arc, there should be no haphazard treatment of the problems. They should be carefully analyzed by both the engineering and shop offices and instructions issued as to the type of rod to be used, the number of passes to be made and the method of welding to be followed. With the advent of welding, we find our methods of design undergoing radical changes and where the lap joint was essential in riveting, it is no longer necessary in welding. The butt-welded joint is stronger and cheaper.

Arc welding machines fall into two categories: d. c. and a. c. While the former are mostly rotating machines, a stationary machine has recently been developed which supplies direct current through a mercury-arc rectifier. This has been specially designed for very light gage stock and is, therefore, limited in its use on railroads. The a. c. welder is usually of the transformer type and is constantly gaining in popularity due to its economical performance and to the fact that it requires little servicing. It is not the aim of this committee to discuss the relative advantages or disadvantages of the various welding machines. These are competently covered in any welding handbook.

Spot welding is a branch of welding by itself and could well be covered by a future study undertaken by this association but it has a bearing on this paper. The spot-welding machine is indispensable in the sheet-metal shop where such things as baggage-car doors, shrouding, coal boxes, step boxes, etc., can be successfully welded by this means. Futhermore, with the advent of lightweight, all-steel freight and passenger cars spot welding becomes an essential part of all repair operations.

The report was signed by J. A. Deppe, (chairman) superintendent car department, C. M. St. P. & P., Milwaukee, Wis.; J. M. Brophy, superintendent car department, Illinois Central, Chicago; J. H. Gimpel, assistant superintendent car department, Wabash, Decatur, Ill.; H. S. Keppelman, superintendent car department, Reading, Reading, Pa.; P. B. Rogers, shop superintendent, A. T. & S. F., Chicago; P. F. Spangler, assistant superintendent motive power S. L.-S. F., Springfield, Mo.; and E. P. Marsh, assistant superintendent car department, C. & N. W., Chicago.

Discussion

W. H. Hartnett, general car foreman, C. & N. W., asked if it is permissible to weld brake staffs and grab handles and the reply was in the affirmative, if properly done.

H. E. Gannett, general welding supervisor, C. B. & Q., said that with the new shielded-arc electrodes, steel welds have been produced with a tensile strength of 85,000 lb. per sq. in., and favorable ductility. He said there should be no question about the possibility of developing the full strength with normal steel.

With regard to Rule No. 23, Mr. Gannett said that it needs revision, as outlined in the committee's report, which possibly does not go quite as far as it might. He said that the selection and training of welders is a problem and that the A. A. R. Welding Committee has prepared standard qualification tests for welders which will be included in this year's report.

Regarding the question of a.c. versus d.c. electric welding, Mr. Gannett said this has never been entirely answered. He indicated that, from the point of view of safety, the high open-circuit voltage with alternating current presents a hazard and that no ground wire should be permitted to be anywhere near a welding operator's head.

Mr. Gannett also called attention to the omission of any reference to gas welding in the committee report and said that this type of welding is just as important as electric welding, if not more so.

The report was accepted for publication in the proceedings.

Lubricants and Lubrication

It is hoped that in analyzing the suggestions submitted consideration will be given to actual conditions as they exist on the various railroads, instead of what might be referred to as theoretical conditions. Possibly some of the suggestions will be applicable and of considerable help on certain railroads and on other railroads might result in a hardship. Therefore, it is hoped that these factors will be considered and where it is not possible for a certain railroad to use to their advantage a certain recommended practice—that instead of saying the suggestion is no good or impossible to be complied with, keep in mind that there are other railroads that might receive great benefit from the suggestions submitted.

The following are factors that cause journals to run hot: Packing not in contact with the journal, packing caked or glazed, rough handling of equipment, insufficient packing, box packed too tight, abrasive or cutting particles in packing, dry packing, cut or seamy journal, defective or broken bearing, bent journal on axle, thread of packing under bearing (waste grab), wiper on edge of bearing, concentrated pressure due to improper fitting of bearing, tapered journal or tapered bearing, bearing not proper size for the journal or shelled out lining, truck out of square, truck side frames out of line, crown of wedge not having proper bearing in box, back of bearing not fitted to wedge, unequal distribution of loading, overload, careless workmanship and poor supervision in carrying out approved instructions.

Lining Spread over the Side of the Journal Bearing

This condition is caused by the brass pounding against the sides of the journal-box lugs compressing the sides

of the brasses and, in turn, the lining cramps the journal, causing the lining to flow over the side. This condition is aggravated when the journal-bearing wedge is narrower through this section than the brass. The width of the brass at this point should be of such a dimension that when the clearance between the wedge and the back of the bearing is taken up by slippage in either direction, the wedge will contact the sides of the box lugs first or at the same time as the bearing does.

To accomplish the above the dimension of the bearing should be reduced slightly. With the present maximum dimensions of the brass the brass strikes the box side lugs ⅛ in. before the wedge does. With the proposed change in dimensions of the brass, the wedge and brass will contact the box side lugs at the same time under maximum conditions.

Any one of the above existing conditions may cause a journal to run hot, and it is recommended that, in order to eliminate as many as possible of these contributing factors, whenever any repair work is being made to the running gear of a car every effort should be made to correct any of the defective conditions noted above.

Rough handling of equipment, particularly by yard crews, and also by road crews, when observed should be immediately called to the attention of the proper operating officer.

On account of the importance attached to comparisons and owing to the various methods of compiling lubrication performance in so far as miles per hot box is concerned, it is recommended that a standard method of compiling this information be set up for all railroads. At the present time it is impossible to make true comparisons among various railroads due to the manner in which the information is compiled.

[The committee report here included more or less generally accepted detailed instructions for care and handling of journal box packing, car oil, journal bearings and other journal box parts. It requested authority to make a study of roller bearings and some of the newer methods of lubricating freight car journals for inclusion in next year's report.—Editor]

The report was signed by J. R. Brooks (chairman), supervisor lubrication and supplies, C. & O., Richmond, Va.; W. G. Aten, mechanical inspector, C. B. & Q., Chicago; P. P. Barthelemy, master car builder, Grt. Nor., St. Paul, Minn.; W. E. Campbell, general car department supervisor, C. M. St. P. & P., Tacoma, Wash.; L. E. Hilsabeck, general car inspector, C. G. W., Oelwein, Ia.; P. J. Hogan, supervisor car insp. and main., N. Y. N. H. & H., New Haven, Conn.; J. M. Holt, general car inspector, Sou. Pac., San Francisco, Cal.; Geo. Minter, division car inspector, N. & W., Portsmouth, Ohio; J. A. Rippberger, general car foreman, Illinois Central, Freeport, Ill.; and M. J. Mills, general car inspector, Pere Marquette, Grand Rapids, Mich.

Discussion

The discussion of this report centered primarily about Rule 66 and its interpretation by car inspection and maintenance forces throughout the country.

The report was accepted and ordered printed in the proceedings.

Standard Classification Commodity Cards

The commodity card, as issued by the A. A. R. under Circular No. T-25, reissued December 17, 1937, by the Transportation Division, covers a recommended practice for standard inspection of box cars used in loading bulk grain, general merchandise, flour, sugar, and other commodities requiring similar inspection. It also covers an inspection card recommended for the purpose of establishing uniformity to the extent as found most practical. This, as you understand, is a recommended card and has been found very practical for use on cars delivered from connecting lines on order.

For an illustration, Railroad *A* orders 100 box grain cars from Railroad *B* for grain loading. Railroad *B* furnishes cars in such bad condition that they require heavy repairs to fit them for grain loading. Consequently, Railroad *A* rejects them, thus causing cross hauling of empty cars back to Railroad *B* and delaying the loading of the grain, as well as causing dissatisfied shippers. This inspection card was adopted to cover cars interchanged on car orders and evidently has remedied the trouble to a large extent as few complaints are now being made since this manner of handling has been adopted. We find that a great many railroads are using this recommended card to good advantage and it appears practical to a large extent for use on American railroads. Some railroads using this card have made further improvements by adding more commodity classifications and following along the lines as outlined in Circular T-25.

We have heard various discussions and differences in opinion on this matter due to the varying requirements of equipment demanded by the shippers, brought about chiefly by the difficulty that in different sections of the country the principal commodity varies, which naturally brings about a difference in car requirements. As an illustration, a Class A car which is an absolutely tight car with good sides, roof, and floor, used for flour, cereal, paper, and other high-class commodities, would be suitable on one railroad for a lading in this class whereas, this same car on another railroad in a different section of the country would represent another class of commodity loading. As the same time, if such cars were loaded on one railroad with a high-class commodity and went to some other point, in most cases the car would have to be cleaned and reclassified before they could again reload it, and in this way it may appear impractical to recommend or adopt a standard inspection and uniform inspection commodity card for the various classes of commodities loaded throughout the country.

This subject has been discussed many times with the result that improvements have been made and various kinds of commodity cards have been adopted, as well as instructions issued covering inspection which, in our opinion, are not uniform and in a large respect cause misunderstandings and differences in opinion which result in unnecessary car handling, empty car miles, and improper equipment being furnished. No matter how efficient the operation is or what procedure is followed in the use of commodity cards, and no matter whether the car travels from one point of the country to the other, it is a known fact that the proper practice to follow is to re-inspect such cars when they are made empty and reclassify them. This, however, does not mean that the railroads cannot adopt a uniform commodity card as well as a uniform set of instructions for our inspectors and agents covering the class of inspection to be performed and the proper disposition to be made of the cars when not fit for the intended lading.

Some railroads employ the 30-day inspection requirement which means that on commodity cards where a card is found with an inspector's date over 30 days' old, such car should be re-inspected and reclassified. This has particular reference to empty cars which have been stored and move empty through a terminal point, or empty cars arriving at a terminal point and having previously been loaded with some class of commodity which makes it necessary to re-inspect such cars for the class of commodity for which they are intended. Please understand that the loading road is held responsible for the condition of the car at the time of loading, as covered by Freight Claim Rule No. 64 which indicates the importance of making these inspections and classifications.

Commodity Card with More Classifications Needed

We feel that with the success of the standard inspection and uniform inspection card as outlined in Circular No. T-25, a recommendation should be in order for a more improved type of commodity card on which more classifications can be added by placing them on the reverse side of the present recommended card. Some consideration might be given to adopting a card that will be readily visible from a distance, and thereby helpful to switch and train crews in their classification, by the application of a letter or symbol; such as, *A, B, C, D,* and *E,* as well as a letter symbol for the clean-out card. We are certain that improvements can be made and that a standard classification commodity card for house cars is practical and we, as a committee, recommend to this association that the matter be referred to the A. A. R. Operating and Transportation Division for their consideration. In this recommendation, we further suggest an extension of the A. A. R. specification as to car conditions and inspection for all commodities in house cars. There are hundreds of various commodities handled and loaded daily and if an adopted set of instructions could be issued by the A. A. R. Transportation Division to all railroads showing the class of inspection required for various classes of lading it would greatly assist the car inspectors and car forces, as well as the agents, in the handling of the proper classification.

Defective Cars Being Loaded

Proper inspection, reconditioning, and reclassification of any class of car as well as empty cars furnished shippers for loading is a very essential operation as far as we are concerned. In one of our large terminals a total of 27,000 loaded cars were shopped during the year 1939. Out of this number, some 22,000 cars had the defects in existence when loaded. Some 5,000 cars had defects originating after loading.

Here in the Chicago area we have a total of 36 railroads and switching lines operating, in which territory something like 130 interchange points as well as some 7,400 industries are located, which these railroads have to serve. It can be appreciated that, with the large amount of freight cars handled throughout the Chicago district, it is important that the car department furnish proper classes of equipment. With the enormous number of loaded cars shopped throughout the country day in and day out, we would recommend that some constructive plan be worked out by this association for expediting the movement of loaded cars, paying particular attention to loaded cars repaired and delayed while in transit.

This indicates the importance of having empty cars properly repaired and reconditioned and properly classified before they are offered to the shippers or to the connecting lines for loading. We have found that differences in opinion of car inspectors, or proper repairs not being made to empty equipment before being set for loading, as well as cars being set for loading without the knowledge of the car forces, result in many loaded as well as empty cars being forwarded to connecting lines, after which various classes of repairs have to be made. The outstanding items of this expense are couplers and parts, wheels, brake beams, center-plate rivets, journal boxes, side-door repairs, complete side doors, cleaning of air brakes, repacking of boxes, and various other defects. We are bringing this to your attention to show the importance of proper inspection and reclassification.

Penalize Misuse of Equipment

We further recommend that some consideration be given by this committee to some sort of penalty to be imposed upon the connecting line or if possible, the line responsible for the misuse of equipment. Many high-class house cars, reconditioned for the highest class of loading are misused by the railroads placing these cars for use of shippers in loading hides and other contaminating commodities. We feel that the road responsible should bear the expense of restoring such car to its original condition for high-class lading.

One of the principal advantages to be gained through proper inspection and reclassification of house cars is retaining them in the highest type loading that the condition of the car will permit. Some railroads in this reclassification program, as well as agents where no carmen are employed, find, after cars become empty, that they are not fit for the class of loading for which they were originally carded. In order that these cars will remain in condition for the highest classification, they apply a clean-out card and if such cars are in a terminal point and the cards are applied by car forces, the operating department is in a position to switch them out properly and place them on properly equipped cleaning tracks. If such cars are away from inspection points and the cards are applied by local agents, they in turn report the numbers and how carded to the superintendent of transportation who moves such cars to the closest available cleaning track, thus eliminating considerable empty mile haul, as well as retaining car in a higher class service.

It is the further thought of this committee that some sort of a clean-out card should be adopted or recommended to be used in conjunction with the standard commodity card.

The report was signed by F. J. Swanson (chairman) general car foreman, C. M. St. P. & P., Milwaukee, Wis.; T. S. Cheadle, chief car inspector, R. F. & P., Fredericksburg, Va.; O. R. Donoho, assistant general car foreman, F. E. C., St. Augustine, Fla.; J. C. Ekas, general foreman of freight cars, A. T. & S. F., Topeka, Kan.; W. B. Henley, general car foreman, Illinois Central, Mattoon, Ill.; F. M. Rezner, car foreman, C. B. & Q., Omaha, Neb.; E. A. Sweeley, mechanical superintendent, F. G. E. X., Alexandria, Va.; Wm. Hartnett, general car foreman, C. & N. W., Milwaukee, Wis.; G. H. Johnson, general car foreman, C. G. W., Oelwein, Ia.; H. C. Knudson, general car foreman, N. P., So. Tacoma, Wash.; and O. W. Rasmussen, general car foreman, G. N., Minneapolis, Minn.

Discussion

In summarizing the points brought out in this report, Chairman Swanson said that hundreds of different kinds of commodity cards are now in use on different railroads, that a standard card is needed and that this association is big enough to recommend one. One member stated that the only way to prevent the misuse of freight cars by the loading of commodities, which damage the

cars, is to apply some penalty to the originating carrier. Another member referred to the loading of commodities in refrigerator cars which, when not properly cleaned out, leave odors and said that the inspection of cars for commodity loading has another advantage in the check which it affords on other mechanical details.

M. E. Fitzgerald, master car builder, C. & E. I., mentioned the difficulty in placing a penalty on the misuse of equipment and said that such a rule was at one time tried but without the desired results. He said that mechanical departments should not be penalized for the cost of cleaning cars due to the misuse of the equipment.

H. E. Wagner, division car foreman, M. P., said that a standard commodity card should be adopted to save money for the railroads.

E. G. Bishop, general car foreman, I. C., urged that delays to loaded cars be avoided by permitting them to proceed to destination before correcting old defects which obviously have been in existence a long time and, consequently, have no direct bearing on safe operation.

C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau, said that this action would save millions, not thousands of dollars annually, to the railroads. He made a motion which was passed that the association take steps to develop an improved commodity card, decide if possible what kind of a car-cleaning card is desirable and also take what further action may be necessary to help reduce the shopping of loaded cars.

The report was accepted and ordered printed in the proceedings.

Freight Car Maintenance

The committee after due consideration of the present situation in the country with respect to railway equipment concluded that it would be wise to concentrate their efforts for the 1940 annual meeting on the question of maintenance of freight cars.

A survey was made of the train detentions due to defective freight-car equipment on six representative railroads during an average three month period. The following figures indicate the causes of detentions, the number of detentions and the percent of the total:

Cause of detention	Number	Per Cent of total
Hot boxes	1,183	52.4
Brake beam failures	265	11.7
Broken pipes	207	9.2
Brakes sticking	195	8.7
Couplers pulled out	73	3.2
All other causes	332	14.8
Total	2,255	100

It will be noted that 85.2 per cent of all detentions can be classified in five general classifications.

If efforts are exerted by the car departments of the railroads of the country to eliminate the detentions in these five general classifications great advancement will be made in decreasing train detentions on account of defective freight car equipment and the result will be a more expeditious movement of freight trains.

Hot Boxes

Of a total of 2,255 train detentions on account of freight-car equipment, 1,183, or 52.4 per cent, were caused by hot boxes. A great deal has been written in the past on the causes of hot boxes, but this matter should again be stressed both from the standpoint of proper method of packing boxes and also from the standpoint of proper truck maintenance. Improper truck maintenance is probably responsible for as many hot boxes as is the improper packing of boxes. The committee feels that a great deal can be accomplished by a closer compliance of all concerned with the provisions set out in Rule 66 of the A. A. R. Rules of Interchange. There are many cars on which the boxes are repacked and the proper method of packing the boxes is not followed.

In some cases when boxes are repacked under Rule 66, defective brasses, defective wedges, and defective boxes are permitted to remain in service. It is believed that more attention should be given to the preparation of packing to be sure that the packing will comply with the A. A. R. specifications. Dust-guard plugs should be renewed at the time of periodic repacking of boxes.

It is felt that the adding of packing to a box should be prohibited unless the packing in the box is removed and the packing to be added thoroughly mixed with the packing removed.

Great attention should be given to wheel-shop practices in an endeavor to eliminate improperly prepared axles.

It is a simple matter to ease off the edges of the collar and the edge of the back fillet when turning journals in the wheel shop. If this is done and the edges are smoothed out there will be no possibility of sharp edges carrying waste out of the journal box up under the brass.

Greater care should be used in handling wheels, truck sides and bolsters in making a truck assembly to prevent journal collars and back fillets becoming nicked, or in marring the journal itself. Very slight damage to the journal, collar or back fillet, will certainly result in a waste grab and cause a hot box.

There appears to be many cases in which trucks are disassembled for wheel change and defective springs are put back into the truck. By defective springs we don't necessarily mean that the springs are broken but they have taken a permanent set. It is appreciated that any springs that are broken will be replaced by any carman, but in many cases springs are replaced in a truck which have a less free height than specified in the Manual of Standards. When springs in this condition are permitted to remain in service there is a great possibility that the journal will be subjected to solid blows which have a tendency to distort the brass. Consequently, it is essential that the springs used in re-assembling the trucks be in proper condition for continued service. The use of snubber springs on equipment of all kinds is recommended as it is felt that snubber springs will, by decreasing the frequency of solid blows, help eliminate some of the causes for hot boxes.

When new cars are built most railroads are very particular that the truck sides are properly mated, but in renewal of defective truck sides the same care is not used. Recently a condition was noted where a truck side had been applied to replace a defective truck side on a coal car. The truck side which was applied was not standard to the car and bore no similar dimensions. As a matter of fact when the truck was re-assembled the spring plank on one side of the truck was 1½ in. further off the rail than on the other side of the truck, yet some very conscientious carman, working under the direction of a car department officer, permitted this truck to be placed in service. Conditions have also been observed where the spring plank itself was too short between the center of the truck frames causing the truck frames to

be bowed in, causing a very heavy distorted pressure on the fillet. The same thing will happen when the spring plank is too long, forcing the truck frame to bow out thus causing a very heavy distorted pressure on the collars. It can be readily seen that a spring plank which is badly bent will also definitely and decidedly distort the proper vertical alinement of the truck frames. If proper precautions are taken in truck maintenance and truck re-assembling it is felt a decrease from detentions from hot boxes will result.

A great deal has been said about hot box prevention in the past as it dealt with proper methods of packing boxes and proper preparation of packing. We can only assume that members of the Association have been so thoroughly impressed with what has been written in the past that they have complied with the recommendations, as far as practicable.

In addition to the attention that has been given to the proper packing of boxes and proper preparation of packing increased vigil should be practiced in closer inspection and maintenance of trucks and truck details.

Brake-Beam Failures

Of the total of 2,255 train detentions on account of defective freight-car equipment 265, or 11.7 per cent were caused by brake-beam failures. Greater attention should be given to the compliance of Rule 63. There are many cars in operation in the country today on which it is evident that Rule 63 is entirely ignored. Recently a number of cars were inspected on which the brake heads were badly worn and out of line. The brake beams were actually bent and in most all cases the tension rod was loose. These conditions, of course, were potential failures. Even though Rule 63 prohibits the use of open-eye hangers we still find a great many cars in service with open-eye hangers.

Greater attention should be given to the proper spreading of cotter keys and the proper size key for the hole in which the key is used. A brand new cotter key can be applied and properly spread, but if the cotter key is loose in the hole and subjected to the vibrations which are common in freight-car brake equipment it will be worn out and lost in a very short time.

It is assumed that on railroads where brake beams are reclaimed, they are so handled in accordance with the A. A. R. recommended practices. If this assumption is correct then the brake beams which are being applied do meet the requirements of the rules. In spite of this there are a great many brake-beam failures which would seem to indicate that additional study should be given to the requirements of the reclamation rule.

From a study of detentions on account of brake beams on a railroad which uses, as standard, a brake-beam support that actually supports the brake beam few detentions have been recorded. This would suggest that a close study and observation be made of the results of some of the improved-type brake-beam supports.

Broken Pipes

The check which your committee made indicates that 9.2 per cent of all detentions due to defective freight-car equipment were caused by broken train lines, broken crossover pipes, and other broken air pipes. There seems to be many reasons and causes for detentions of this type, which in general were due to a rusted out condition of piping, pipe supports, cylinder supports, brake-valve brackets, etc. In many cases loose pipe clamps have permitted pipes to vibrate and being directly responsible for broken air pipes. There are many improved pipe clamps on the market which, if used, will prevent this type of failure.

Several failures of pipes have been found where it was evident that the bent pipe required in connection with most air-brake applications have not been properly stress relieved after being applied, as set forth in the recommended A. A. R. practices. This is particularly true in the application of AB brake piping. Several failures have been observed on account of improperly supported piping on the older type cars equipped with detachable brake cylinder reservoirs. In most cases the pipe and fittings, as well as the supports, are found badly deteriorated.

There seems to be a tendency to apply brake cylinders and brake reservoirs with bolts which do not properly fit the holes in the brackets. The brake cylinders and the reservoirs appear to be tight when first applied, but after a short period of time vibration causes the fastening to loosen and allow the cylinders and reservoirs to vibrate badly and even to move under brake applications.

Brakes Sticking

Of the total detentions checked, 8.7 per cent were due to brakes sticking. There are many reasons for brakes sticking on freight trains which are not entirely chargeable to defective air equipment. There have been many cases where improper handling of air brakes by the engine crews are responsible for brakes sticking. This of course is not within the jurisdiction of this association, but it is felt it is important enough to mention in this report.

It has been observed that at several terminals there seems to be a misunderstanding, or a failure to comply with the A. A. R. recommended method of terminal testing of air brakes. If these recommendations are complied with there will be a greater assurance that the brakes in the train are in proper working condition and this naturally will eliminate a great many failures due to brakes sticking.

Apparently, in spite of all the work that has been done to date on wasp excluders a satisfactory excluder has not yet been developed. With this in mind it becomes more apparent that proper terminal air tests should be made to detect cars in which wasp nests have made the retainer valve ineffective.

Several cases have been observed where AB brake piping was not put up in accordance with recommended practices, particularly in regard to the branch pipe length. If the branch pipe length is not put up in accordance with recommended practice it is possible to have a failure due to brakes sticking on account of a retarded orifice effect in the air equipment.

Couplers Pulled Out

Under the general heading of couplers pulled out it was found that 3.2 per cent of all detentions could be attributed to this particular cause. While this percentage of total train detentions due to defective freight-car equipment appears to be rather small and may be considered insignificant, it is a fact that failures of this type are often accompanied by more serious damage to equipment. It is also a fact that failures of this type result in delays to trains because of the difficulties in handling the equipment after the coupler has been pulled out so as to get it set out in a side track or a repair point.

There are many causes for failures of this type which could generally be summed up as a failure properly to maintain the draft gear and coupler attachments. A great many non-approved draft gears are still in service and have a considerable bearing on failures of this type. The use of wrought-iron riveted yoke attachments, with the great possibility of failure, contributes extensively to the possibility of coupler failures.

Couplers and coupler attachments are subjected to severe conditions of stress reversals even under the best

conditions of maintenance. Consequently, great care should be exercised in maintaining properly the coupler butts, cross keys and retaining keys in order to eliminate as much as possible the free slack.

Consideration should be given to the promulgation of a more satisfactory maintenance instruction regarding couplers and draft attachments and proper maintenance of draft gears. The reclamation of draft attachments should be carefully supervised in order to eliminate, as much as possible, free slack in the draft attachment parts.

The report is signed by D. J. Sheehan, (chairman) superintendent motive power, C. & E. I., Danville, Ill.; J. McMullen, superintendent car department, Erie, Cleveland, Ohio; W. A. Bender, master car builder, Alton, Chicago; C. Claudy, master car builder, G. T. W., Battle Creek, Mich.; J. R. Hayden, superintendent car department, M. K. & T., Denison, Tex.; J. E. Keegan, chief car inspector, Pennsylvania, Chicago; G. E. McCoy, assistant general superintendent motive power & equipment, Canadian National, Toronto, Ont., Canada, and S. O. Taylor, master car builder, Mo. Pac., St. Louis, Mo.

Discussion

J. A. Deppe, superintendent car department, C. M. St. P. & P., referred to that part of the report dealing with hot boxes and stated that experience on the Milwaukee indicates the necessity of checking journal boxes for waste grabs after cars have been switched in train yards and are reassembled in trains ready for departure.

P. J. Hogan, supervisor car inspection and maintenance, N. Y. N. H. & H., agreed with the previous speaker and said that as many as 90 waste grabs a month were formerly detected by this means at one yard of the New Haven. By proper inspection, jacking the boxes and correcting unsatisfactory journal conditions, the subsequent development of hot boxes from this cause is largely avoided. Mr. Hogan referred to a new journal bearing, now standard on the New Haven for both cars and locomotives, which he said will not permit the development of waste grab.

T. S. Cheadle, chief car inspector, R. F. & P., said that waste grabs are caused by improper packing of boxes and stressed the need for uniform method of packing.

Another member said that hot boxes are caused by worn-through chill wheels and this thought was substantiated by J. E. Keegan, chief car inspector, Pennsylvania, who also said that too much packing is frequently placed in the boxes.

W. J. McCloskey, general car foreman, I. C., questioned the practice of delaying trains after they are made up ready for departure in order to check journal-box conditions. He said that at the Centralia, Ill., yards, a check is made of incoming trains, any defective journal-box conditions, such as cut journals, cracked brass, waste grabs, etc., being indicated by the temperature of the box. He said that, by giving necessary attention to these cars, the number of car miles per hot box on the I. C. has been increased to about 200,000.

C. P. Nelson, general car foreman, C. & N. W., called attention to the need for tight journal-box lids to exclude dirt and moisture and mentioned tests now being conducted with a special spring and latch design on the C. & N. W.

F. A. Shoulty, assistant superintendent car department, C. M. St. P. & P., questioned the suggestion in the committee report that spring snubbers tend to prevent hot boxes, since snubbers, he said, are designed primarily for maximum load conditions and are, therefore, not so effective in reducing vertical shocks with attendant possible waste grabs in hot boxes when cars are empty or carrying very light loads.

In reply to this remark, Chairman Sheehan said that comments in the committee report about snubbers may be incorrect, but he doesn't think so. He said that spring snubbers are not designed for maximum load conditions only, but tend to reduce vertical vibration at all loads and hence prevent the build-up of over-solid blows which may cause broken brasses. Mr. Sheehan urged the taking of sufficient time to inspect cars and correct defective conditions at train yards, as the place to delay a train is before it starts rather than after.

E. G. Bishop, general car foreman, I. C., called attention to the use of a front plug by some railroads in packing journal boxes and said that all railroads should either use the plug or not use it.

On a motion by J. A. Deppe, superintendent car department, C. M. St. P. & P., this question of a front plug was ordered referred to the Lubrication Committee, whose recommendations, if approved, would be submitted to the A. A. R. for possible adoption as standard practice. Mr. Deppe also checked the thought that journal-box lids should be made more nearly dust-tight and not serve simply as "sun shades."

C. T. Ripley, chief engineer, Technical Board, Wrought Steel Wheel Industry, called attention to the effect of modern high-speed operation in both passenger and freight service in increasing the difficulty and cost of wheel maintenance and said that for satisfactory results, wheels must be turned more frequently and kept in better condition. Mr. Ripley referred to the necessity for increased accuracy in wheel shop work and said that many shops are now employing tool equipment and practices which turn out work accurate to within .005 in., or less.

Regarding wheel-tread contour, Mr. Ripley referred to the controversial question as to the effect of different treat contours on riding qualities and cost of maintenance. He said that the action of the A. A. R. in 1932 in discarding the secondary taper to prevent thermal checks resulted in decreased service life, due to the necessity of turning the tires more frequently on account of hollow treads. He said that the latest improved design has a secondary taper and a well-rounded edge, which give 30 per cent longer life between turnings. He thinks that this design also gives better riding but on that point there is a difference of opinion. In freight-car service, Mr. Ripley maintains that the same general principles apply as for passenger equipment and that a drop-off taper and larger radius are required.

E. W. McDonald, manager of sales engineering, Griffin Wheel Company, checked Mr. Ripley's statement regarding the need for a drop-off taper on the wheel contour and said that there is no objection to a cylindrical tread if desired.

In connection with brake beams, one member stated that where beams are reclaimed in accordance with the present A. A. R. rules, there are few broken truss rods or failures of other parts.

Mr. McCloskey presented a strong argument for better fitting brake pins and cotters and showed the convention a number of samples of new or reclaimed pins in which $\frac{3}{8}$-in. cotters, measuring slightly less than $\frac{3}{8}$-in. in diameter, were applied in $\frac{7}{16}$-in. holes and in one case in a $\frac{1}{2}$-in. hole. Mr. McCloskey said that the service life of a cotter in such enlarged holes is necessarily very short and suggested that the members check the specifications on their individual roads and make sure that brake pins and cotters meet the desired dimensions. He said, "We have enough slack in brake pins and cotters without buying any."

The report was accepted.

In preparing the metal surfaces of cars for painting, the new high-tensile steels are so light that they will not stand the heavy sandblast operation without buckling, and so (necessity being the mother of invention) we have had the paint manufacturers develop chemical cleaners, and I am glad to say that today these cleaners are doing an efficient job.

After the metal is cleaned, comes the priming coat. This, we all agree, is the most important part of the job, like the foundation of a building. Here too the paint manufacturers have made great improvements. The iron-oxide primers they are giving us today are a great improvement over the old primers. They stand contraction and expansion and give a durable elastic foundation for the succeeding coats.

Surfacing and knifing compounds are still being used by some of the railroads, but not to the extent that they were before. After the car is sanded or rubbed, synthetic enamels or pyroxlin lacquers are applied; most of the roads having discarded color and varnish. The synthetic enamels and lacquers have improved the appearance of the car and from all indications they are going to stand up as well in service as the old paint and varnish system. Three coats of enamel or lacquer present a durable and fine looking job. The schedule of painting has been reduced as much as seven or nine days from the time required to apply the old color and varnish system.

On the interiors, the changes have been even greater than on the exteriors. The old cars were quite uniformly painted and grained in mahogany or walnut, and we all developed grainers who were so competent in their art that no one but an expert could tell whether the interior was wood or metal. The side walls, today, are covered with leather, cork, Flexwood, Plymetal, and Presdwood. Practically all of the operations must be sprayed. Synthetic enamels are being used, which produce a desired rubbed effect without any actual rubbing. The interiors are full of polished extrusions, and each design of interior presents a problem all its own. Due to the use of the synthetic enamels and modern spray guns, the interior painting schedules and labor costs have also been reduced. Masking paper is being used in great quantities for striping and lettering on the exterior, and for protection of mouldings, air-conditioning grilles, glass, etc., on the interiors, and while the material cost is high, the results obtained more than justify the expense.

All of these changes present problems for the foreman painter. Unfortunately, during the depression, our apprentice-training system was greatly curtailed, and in some instances abolished. Then years took a great toll of our old, time-tried mechanics, and while the young new-comers are willing and eager to learn, they require more supervision and more training in an art that is somewhat new, even to the foreman.

Rebuilt Equipment Looks Like New

Many railroad shops have been remodeling and making their old equipment into up-to-date streamline trains, and when finished, look like new equipment; and here is where the master painter comes in to play an important part. If the exterior is an all-welded car, the first operation is to either sandblast or clean it to the equivalent of sandblast.

Sandblasting is gradually being displaced by chemical cleaners and rotary discing machines, which reduces the labor considerably. The use of the rotary discing machines makes the steel or aluminum an excellent bond for the primer to adhere to. Where welding is used, great care must be exercised by the painter to see that all traces of welding flux are removed before the primer is applied.

Painting applied over welded surfaces that have not been cleaned properly, will start to deteriorate in less than six months, and the flux will come right through all coats of paint. None of these chemical cleaners are injurious to a man's health, nor will they affect his hands. After the steel body is properly cleaned and etched, it is ready for the priming coat.

Many roads have now added striping to the exterior of the cars. Striping and lettering was always an occupation that had to be put on by a decorator. Today adhesive masking paper is used extensively, and the colored stripes and color lettering are applied by spraying, which does an excellent job and has played an important part in lowering the costs.

Spraying of lettering and striping can be done in two ways on the exterior of the car. One way is to spray the letters on, after the last coat of body color is applied by masking the body color of the car. The other way is to spray the striping color on the car after the body has been rough-stuff rubbed, and then mask the striping color. Durability tests have been made on both operations and at this time it is not known which is the better, but letters applied by the spray are outlasting those put on by hand. Gold leaf lettering and striping is still a problem, and much discusion can be had regarding the durability, the number of months of service, and the cleaning it will stand before it has to be renewed.

Interior Painting

On the interior of the car, the problems of the master painter have increased tremendously. The architect has incorporated many new features. Synthetic enamels of many different colors are sprayed on, and after they are dry look as though they have been varnish rubbed. Color distribution is accomplished by the use of shields and masking paper. This has reduced the cost greatly over paint and varnish applied by hand.

Wall coverings applied by the painter on the pier panels, bulkheads and wainscotings, such as sheet cork, Flexwood veneers, leather and fabrics, presents problems to the master painter that he has never been up against before. In cementing these materials on, special cements and glue must be used, and either lacquer or several coats of wax must be applied on top of the Flexwood to give service when the car is cleaned at the terminals. These and many other features in decorating the interior of the car have gone a long way to bring back the traveling public.

The operation of modern, lightweight equipment, with constant demands for increased speed, requires a competent and experienced painter on every railroad. The railroad needs the maximum of service from the paints which do so much to beautify and preserve these modern cars and locomotives. Designers, engineers, and mechanical officers on all railroads strive to create improved types of cars and locomotives, which bring increased revenue to their roads. Yet it is important that the final and lasting impression that paint gives to equipment should have its application directed under the guidance of a skilled foreman. Some railroads have displaced their paint foreman entirely. Severe and drastic cuts in operating expenses may have made such an elimination necessary. However, with the prospect of increased earnings on the part of the railroads, it would seem to add to their permanent economy if skilled master painters, who apply

paints and kindred products amounting to millions of dollars, would be replaced to their former positions by the railroads of this country.

The report was signed by C. L. Swing (chairman) general foreman, Pullman Standard Car Mfg. Co., Chicago; J. L. Askew, foreman painter, S. A. L., Portsmouth, Va.; R. B. Batchelor, freight-car painter, Wabash, Decatur, Ill.; L. B. Jensen, passenger shop superintendent, C. M. St. P. & P., Milwaukee, Wis.; J. A. Pritchard, master painter, A. T. & S. F., Topeka, Kan.; D. C. Sherwood, foreman painter, N. Y. C., West Albany, N. Y.; M. Thierry, foreman painter, N. & W., Roanoke, Va.; D. J. Watson, foreman painter, G. N., St. Paul, Minn., and Robert Woods, master painter, G. T. W., Port Huron, Mich.

Discussion

Following the presentation of this report, Secretary Kartheiser read a contributed discussion which brought out or emphasized the fact that modern Painting procedure is vastly different from that of only a few years ago and that railway car painters must be on the alert to keep in touch with the latest improved practices.

W. C. Sherwood, foreman painter, N. Y. C., asked if the cleaners referred to in the committee report will remove mill scale and the answer was in the negative. Mr. Swing stating that a rotary discing machine is used which gives as good results as sandblasting. Another member stated that sandblasting puts steel surfaces in better condition for paint than other method.

J. M. Brophy, superintendent car department, I. C., asked how it is possible to get away from the disc marks or rosette finish, which is characteristic of the use of rotary discing machines and Mr. Swing said that this finish simply gives a good foundation surface which is entirely covered up by the prime, surface and knifing coats. He said that the discing machine is not good for removing paint from large surfaces but, on new cars simply roughs up the surfaces, without the necessity of sandblasting.

Another member said that on passenger equipment sandblasting is used on both the outside and inside and that every effort should be made to improve sandblasting equipment and methods to remove or forestall the demands for legislation against it.

D. J. Sheehan, superintendent motive power, C. & E. I., said that sandblasting is definitely on the way out, due to legislation already in effect in many states.

The report was accepted for printing in the proceedings.

Report on Loading Rules

As a result of study of conditions surrounding many loads on open-top cars, suggestions received from the members during the year, and suggestions presented to the committee at the time of meeting for the preparation of this report, the committee proposes the following additions to, and changes in the A. A. R. Loading Rules, and recommend they be referred to the Association of American Railroads for consideration by the A. A. R. committee.

General Rules

Rule 5.—Recommend two new sentences be added to the second paragraph of this rule, to read: "Blocking, bracing, etc., used to prevent loads from shifting should, where possible, be placed on and secured to floor."

"Blocking used in cars having steel floors should be secured to floors with bolts."

Reason.—It has come to the attention of the committee that some shippers of sheet steel are applying bracing to the top of piles of sheet steel, bracing extending the full width of the car and tied to the bundles. This does not satisfactorily protect the load from moving sidewise as braces are frequently found broken and the load shifted.

The rules do not now specify the manner of securing blocking to cars having steel floors.

Rule 9.—Recommend this rule be changed to show that green saplings are a permissible substitute for hardwood and other stakes. It is also recommended that the size and kind of stakes, and the sizes of green saplings permitted as substitutes for stakes, be shown under the description of the various individual figures.

Reason.—It is not generally understood that green saplings may be substituted for hardwood stakes.

Rule 10.—Recommend the use of No. 9 gage wire for intermediate and top stake ties where No. 11 gage wire is now permitted in the rules.

Reason.—No. 11 gage wire appears to be too light for this purpose as it is frequently found broken.

Drawings

Fig. 27.—Recommend second sentence of Item C be changed to read.—"Pass the two top items nearest to ends of pile underneath the top layer and the two inside items across top of pile."

Reason.—To protect top layer from falling off car when poles in top of pile shift beyond outside pair of stakes.

Fig. 29.—Recommend second sentence of Item D be changed to read:—"Pass the two top items nearest to ends of pile underneath top layer and the two inside items across top of pile."

Reason.—To protect the top layer from falling off the car when poles in the top of the pile shift beyond the outside pair of stakes at the end opposite the overhang.

Fig 32.—Recommend Item D, under the description, be changed to read:—"2 strands, 1 wrapping, ¾-in. by .035-in. bands. Substitute if desired 2 strands, 1 wrapping ⅜-in. by .050-in. bands."

Reason.—We believe the ⅜-in. by .050-in. bands will prove equally as efficient as the ¾-in. by .035-in. band. This recommendation to also apply to any other figures where ¾-in. by .035-in. bands are specified for top stake ties.

Fig. 37.—Recommend the elimination of last sentence of Items J and K.

Reason.—to prevent car sides from spreading and loads from shifting endwise.

Fig. 38.—Recommend the elimination of last sentence of Items K and L.

Reason—To prevent car sides from spreading and loads from shifting endwise.

Fig. 110.—Recommend that Item C be changed to provide for a 2-in. by 4-in. strip, nailed to the floor against the wheels nearest the car sides.

Reason.—Wheels loaded per Fig. 110 are shifting sidewise, causing slack to develop in load, resulting in damage to journals.

Fig. 111.—Recommend that Item C be changed to pro-

vide for a 2-in. by 4-in. strip, nailed to floor against wheels nearest car sides.

Reason.—Wheels loaded per Fig. 111 are shifting sidewise, causing slack to develop in load, resulting in damage to journals.

Fig. 172.—Recommend that Item G be changed to provide for the application of bands with sufficient slack to permit of slight oscillation of machines.

Reason.—Bands are breaking as a result of being applied with too much tension.

Closed Car Rules

It is recommended that these rules be amended to include "Side-Bearing Clearance Limits" as now specified in Rule 3 of the rules covering loading on open-top cars.

On account of difficulty being experienced with bulging doors of automobile cars when loaded with cotton and not having door protection, your committee feels that the attention of all concerned should be directed to Item J as it appears on page 7 of the closed car rules issued by the Operating-Transportation Division of the A. A. R., which item provides for the use of door protection.

It has been our practice, in previous years, to include in our report as a matter of information, the report of the A. A. R. Committee on Loading Rules. We have not included it this year for the reason that the information as contained in the report of the Committee, issued in A. A. R. Circular D. V. 980, appears in Supplement No. 1 which became effective as of September 1, 1940, and with which we believe all are familiar.

In the report submitted at the last annual meeting we included a copy of a circular letter issued from the office of the Secretary, Mechanical Division, Association of American Railroads, dated September 9, 1939, addressed to the Voting and Associate Members of that Association, regarding reports covering Experimental loads and loads which required adjustment enroute. We are informed that the A. A. R committee will appreciate any and all information concerning such loads and any recommendations which may be made to further improve the present loading rules. We therefore respectfully request that you refer to the Proceeding covering our last annual meeting, particularly the letter above referred to, and reissue such instruction as may be necessary to insure reports being made on all experimental loads and those which require adjustment.

The report is signed by H. H. Golden, (chairman) supervisor A. A. R. Interchange and Accounting, L. & N., Louisville, Ky.; H. T. DeVore, chief interchange inspector, Youngstown Car Inspection Association, Youngstown, Ohio; W. P. Elliott, general car foreman, T. R. R. A. of St. Louis, St. Louis, Mo.; Jos. Grimmer, master car builder, E. J. & E., Gary, Ind.; S. C. Montgomery, general car foreman, Illinois Central, Memphis, Tenn.; E. N. Myers, chief interchange inspector, Twin City Joint Car Inspection Association, St. Paul, Minn.; C. R. Weigmann, chief interchange inspector, St. Louis & E. St. Louis Joint Inspection Bureau, E. St. Louis, Ill.; and L. T. Donovan, A. A. R. loading inspector, Pittsburgh, Pa.

Report on Interchange and Billing

Many questions have been submitted to the committee which will not appear in this report. These questions are being held in open docket for further consideration and study. Those submitting questions not covered herein may rest assured that all such questions were thoroughly discussed and were carried over for further study, due to the nature of the subjects and necessity for further investigation.

Proposed Changes in Rules of Interchange:

Rule 3, Item (5), Par. (r)—Add the following to note on the bottom of page 20, following item (5): "Or relocated as provided for in rule 49."

Reason—Because of revision of rule 49.

Rule 4, Sec. (g)-2—Change to read: "Longitudinal sills, if bent in web in excess of 2½ in.; flanges only, if bent, are not cardable."

Reason—Bent flanges not extending into the web do not impair the sills sufficiently to warrant repairs, and our study indicates that many cars so carded are not repaired until the cars are shopped for general repairs.

Rule 4, Sec. (g), Par. 3—Revise completely to read: "Defect cards shall not be required for the following damage when not directly associated with delivering line defects: (a) Push-pole pockets—all cars, (b) Side-door fixtures attached to door or car body-house cars."

Reason—After careful study of a great accumulation of defect cards, the committee concludes that many cards are being issued for side-door fixtures which cannot rightfully be considered unfair usage inasmuch as no associated damage is carded at the time the cards reviewed were issued. The elimination of this carding will make for an improved interchange condition and eliminate considerable misplaced responsibility.

Rule 17, Par. (d)—Add the following in the sixth line, following the words "Gear supports": "Air-brake cylinder and reservoir brackets, floating-lever brackets, top side bearings, top center plates, brake shaft and top-rod supports on tank cars."

Reason—The authority already provided in the present rule was delegated as a result of the hazard incident to applying hot rivets to tank cars. We should have the additional authority to repair the additional items now incorporated, in order to carry out the theory of safety.

Rule 49—Correct proposed form, as shown in Circular DV-982, Report of Arbitration Committee, Dated Chicago, May 27, 1940, to provide for location of the receptacle on the outside of the car, and eliminate the authority now granted providing for the application of defect-card receptacles under the car. We recommend the rule revision as follows: "When receptacle is used, same should be in accordance with A. A. R. recommended practice specifications, applied one per car, located on outside of car, on side of car from which air-brake stenciling is observable, and as near as practicable to car number. On tank cars not constructed with side sills, such receptacles should be located on under side of running board, facing outward, located as near as practicable as above defined."

Reason—To eliminate hazards of inspection where receptacles are located under equipment, necessitating that inspectors go under cars in train yards to check defect cards or to determine whether or not defect cards are carried on cars bearing cardable defects.

Rule 66, Sec. (b), Page 129—Add the following, after the word "necessary" and before the words "all boxes": "Renew all missing dust-guard wedges or plugs."

Reason—From the information available, dust-guard wedges or plugs are not being renewed at the time of periodical repacking of journal boxes, and it is the opinion of your committee that the rules should provide for the renewal of such dust-guard wedges or plugs found

missing, to prevent dirt and foreign matter from entering the boxes, due to the elimination or failure to renew missing dust guard wedges or plugs.

Rule 66, Par. 2 of Sec. 11, Specifications for Standard Method of Packing Journal Boxes—Eliminate the last sentence of paragraph 2, reading: "Journal bearings having linings loose, section broken out, spread over the side or worn to the brass, should be renewed."

Reason—This sentence is superfluous. Our forces should be governed strictly by the provisions of rule 66, sec. (j), items 1 to 6, inclusive, which cover the now recognized bearing defects which necessitate their renewal.

Rule 71, Par. 3—Add sentence to third paragraph, reading: "Length of flat spots must be measured by gage shown in Fig. 1 and applied as shown in Fig. 2."

Reason—Present rule does not provide method of gaging flat spots referred to and information would tend to indicate that many wheels are being condemned under this rule where the spots are not actually flat. The committee would refer all concerned to paragraph 98 of the Wheel and Axle Manual, which definitely prescribes that these spots must be flat.

From the information developed, the committee concludes that, due to the fact that the rule does not provide definite method of gaging, wheels are being removed prematurely, and through use of definite gage and method of gaging, wheels now removed prematurely will be continued in service.

Rule 75-A—The committee recommends complete revision as follows: "Combination tread defects, shelled out, flat spots, brake burn comby spots; cast iron wheels having a series of defects extending circumferentially on the tread for a continuous distance of 12 in., having at least three defects with less than 3 in. of good metal between the defects when such defects consist of any or all of the following:"

Reason—The present rule now covered in Supplement No. 2 is not clear, and considering the great number of questions and controversies arising as to its intent, the committee feels that the above recommended rule will clarify and make for a practical application.

The committee again wishes to stress the importance of strict compliance with the approved rules of interchange and billing. Much of the work of the inspector at interchange points, and delay to prompt movement of loaded and empty cars, would be greatly expedited if the present approved rules of interchange and carding were given more careful consideration by handling lines. What is most needed is honest, fair handling and application of these rules and regulations, rather than submission of suggested changes.

As a matter of study and information, the committee draws attention of all concerned to the monthly reports made by the Chicago Car Interchange Bureau, Superintendents' Association of St. Louis, and other similar bodies, treating with delay to loaded and empty equipment. These records reflect the many cars being delivered in interchange with extensive underframe and superstructure cardable damage, not defect carded, the delivery in interchange of empty equipment containing refuse, and first-class cars badly contaminated, which conditions warrant careful consideration and study by all concerned.

If provisions of Rule 4, sec. (a), were strictly complied with on all lines, the great number of cars reaching interchange with questionable cardable damage and extensive damage to underframe and superstructure which can definitely be allocated as cardable defects, would not so move. The rule is clear that when cars are so damaged they must be carded at the scene of the accident, or at the first terminal through which the car passes after such accident. It is evident, from information submitted to your committee, that this rule is being flagrantly violated.

The same situation has been developed in connection with Rule 44 damage, and it is apparent that very little, if any, attention is being given to the protection of Rule 44 damage through carding at the time of damage, or application of information cards, as provided for in the rules.

The committee suggests that the particular rules referred to, and those bearing on the proper protection of such damage, be circularized by individual railroads, with instructions that such rules be strictly complied with.

Billing for Car Repairs

The sub-committee which was assigned to consider questions relating to billing for car repairs submits for your consideration and action the following opinions on the questions hereunder, and also recommendations for proposed changes in the present A.A.R. rules of interchange:

Rules 9 and 10—Inasmuch as both these rules include information required on billing repair cards in connection with wheels and axles, it is recommended that Rule 10 be consolidated with Rule 9.

Reason—To facilitate reference.

Rules 9 and 23—Add a paragraph to Rule 9 as follows: "When welded parts have to be annealed in accordance with requirements of Rule 23, repair card must so state."

Reason—To coincide with Item 281 of Rule 107, indicating to owner that Rule 23 has been complied with.

Rules 9 and 98, Section G, Note 1—Add a note under the heading "Wheels and Axles R&R," in Rule 9, reading as follows: "See also Rule 98, sec. (g), Note 1."

Reason—To facilitate reference.

Rules 9, 17, Int. B-5 & B-8, Rule 43, Int. 2, Rule 66, Sec. J.—Question—Is it permissible to use symbols or abbreviations in writing up billing repair cards, which are not expressly authorized in the A.A.R. Rules?

Answer—No. Symbols or abbreviations should not be used unless authorized by the A.A.R. Rules.

Recommendation—That the A. A. R. set up standard symbols which may be used to designate the following on billing repair cards:

Not equipped with brake-beam safety supports.
Not equipped with bottom-rod supports.
Not equipped with removable chair castings.
Defective brake shoes.
Defective journal bearings.

Reason—To reduce the volume of recording on billing repair cards similar to the practice now permitted for air hose as outlined in Rules 9 and 56.

Rules 68 and 82—Question—A pair of cast-iron wheels is removed on account of owner's defect on one wheel while the mate wheel is not condemnable for any defect in Rules 68 to 83, but has a slid flat spot or spots not condemnable when wheels are under the car. What credit should be allowed the car owner for such a mate wheel?

Answer—Second hand value. Last sentence of opening paragraph of Rule 82 reads as follows: "Wheels which do not take the remount gages, or which have not reached the limits specified below (a, b, c and d), shall be classed as second hand."

The fact that Par. 164 of the Wheel and Axle Manual states that such mate wheels are scrap has no bearing upon credit which must be allowed for such wheel.

Rule 87, Sec. A—Bill on authority of defect card covering bolts in place of rivets not permissible after one year from date of wrong repairs (or nine months

(*Continued on page 507*)

Fuel and Road Supervisors Discuss

Equipment-Operating Problems

Performance of modern brake equipment, steam locomotive firing practice, and Diesel-electric locomotive operation are among the subjects of committee reports and papers presented at the fourth annual meeting of the Railway Fuel and Traveling Engineers' Association.



G. M. Boh, President

FOR the first time the problems of the road supervision of Diesel-electric locomotive operation were the subject of consideration this year by the Railway Fuel and Traveling Engineers' Association at the fourth annual meeting held at the Hotel Sherman, Chicago, October 22 to 25, inclusive.

Addresses and Papers

The program was divided into three major classifications: those subjects dealing with motive power and its operation; those subjects dealing with air brakes and train handling, and fuel. For the convenience of members, the program was arranged with a Mechanical Day, an Air-Brake Day, and a Fuel Day. On the latter day T. O. Weeks, chief dispatcher-division trainmaster, Missouri Pacific, Little Rock, Ark., in an address on fuel economy stressed the importance of supervisors considering the psychological effect of their actions on the men in the ranks in order that enthusiasm for the job might be fostered. D. S. Ellis, chief mechanical officer, C. & O., Cleveland, Ohio, commented on the influence which this association has had on and the support it has rendered to, the development of higher standards of locomotive maintenance.

John M. Hall, director of the Bureau of Locomotive Inspection, Interstate Commerce Commission, in an informal address, said that there was no better team than the traveling engineer, the enginehouse foreman, and the master mechanic for keeping locomotives in excellent operating condition. He referred to the tremendous improvement in the number of accidents and casualties resulting from locomotive failures since the boiler- and, later, the locomotive-inspection laws have been in force and expressed his appreciation for the cooperation with which railroad men had worked with the Bureau.

A brief talk was also made by Roy V. Wright, editor, *Railway Mechanical Engineer,* in which he congratulated the association upon the thoroughness with which its reports were prepared, as well as its extensive and clearly focused discussions. He pointed out the necessity for giving especial attention to the promotion of safety, both because of the increased business which the railroads must handle in connection with the national defense program, and the less experienced and new workers that will be called into service. Excellent safety records have



← W. H. Davies, Vice-President



L. E. Dix, Vice-President →



← A. A. Raymond, Vice-President



T. Duff Smith, Secretary-Treasurer →

been made in carrying passengers. This is true also as to employees, but much still remains to be done in improving the records. In responding to these remarks, F. P. Roesch paid high tribute to the *Railway Mechanical Engineer* for the part that it had played in the co-ordination program of the mechanical associations.

In opening the first session of the meeting the president of the association, G. M. Boh, district road foreman of engines, Erie, emphasized how essential full discussion of the reports is to the value of the meeting and to the reference value of the proceedings after the meeting.

In the following pages are summaries and abstracts of the principal addresses, papers, and reports which made up the program of the meeting. In addition to those printed here, a report on The New York Central locomotive tests conducted at Selkirk, N. Y., was presented by W. E. Collins, engineer of tests, New York. It contains a complete exposition of this method of testing locomotive boiler performance and gives the results obtained in the marked improvement in locomotive drafting. An extensive abstract of it will be printed in a later issue.

A. G. Hoppe, assistant mechanical engineer, C. M. St. P. & P., the chairman of the Committee on New Locomotive Economy Devices, said that the committee had nothing of importance in the nature of new equipment to bring to the attention of the association this year. He reported that the front delivery stoker had been installed and tested on the C. M. St. P. & P., and that, while the test results are not yet ready for publication, the indications are that its performance was excellent. He said that circulators were being applied more generally in an attempt to improve the condition of side sheets, and that indications are that they effect some improvement. He called attention to a return of interest in direct steaming and to some extension of the installation of modified type A superheater units.

Address by Mr. Ellis

D. C. Ellis, chief mechanical officer, C. & O., told of attending meetings of this association in the past and commented particularly on the improvement in performance reflected in the report on Locomotive Utilization. All railroads cannot have long mileage runs, he said, but other means have been found by which the monthly locomotive mileage can be built up. Even in the case of steam switch engines coaling, cleaning the fire, filling the tank and lubricating is being done during the 20-min. lunch period of the crew. He congratulated the association on the support it had given to good maintenance of locomotives.

The early efficiency experts, he said, were considered a necessary evil. Even they, however, served an important purpose and, today, the members of this association have to be efficiency experts in their own field. Present railroad men are the beneficiaries of many improvements in rolling stock, track, signals, and other facilities. A continuance of progress along these lines rests in the hands of present railroad men, he said. In this connection he suggested that when considering changes or improvements the history of similar developments be first completely reviewed in order that a clear picture of the problems still needing attention may be attained.

An Evening of Moving Pictures

On Thursday evening, October 24, a program of moving pictures was presented to which the Railway Fuel and Traveling Engineers' Association and the Master Boiler Makers' Association contributed. A. A. Raymond, superintendent fuel and locomotive performance, N. Y. C., showed colored moving pictures of the action of draft on the fuel bed in a locomotive firebox at various rates of firing. This picture, developed by the New York Central with the cooperation of the Standard Stoker Company, Inc., was taken through 6-in. openings through the water legs of the firebox and through the firedoor. The openings permitted photographing the interior of the firebox close to the fire level at the front and back corners, near the center and through the front water leg, over the rear end of the arch. The motion in the firebox was four times faster than shown in the picture. The pictures were taken both with the HT and FD types of stokers at firing rates per hour of 4,000 lb., 7,000 lb., 11,000 lb., and 13,000 lb., and showed clearly the movement of coal in the firebox under the influence of the draft. Following the test runs pictures were also taken of the condition of the fires.

An Oxyacetylene Association film, presented by the Master Boiler Makers' Association, showed the use of the Oxygraph cutting machine on production work where several pieces can be cut at once from the same pattern.

A Pittsburgh Coal Company colored movie was also shown. This was in the nature of a trip through one of the mines and it covered the complete process of production from the mine to the railroad car.

Officers Elected for 1941

The new president of the association elected to serve during 1940-1941 is A. A. Raymond, superintendent fuel and locomotive performance, New York Central, Buffalo, N. Y. The three vice-presidents elected for a term of one year are J. A. Burke, supervisor of air brakes, A. T. & S. F., Topeka, Kan.; L. E. Dix, fuel supervisor, T. & P., Dallas, Tex., and W. C. Shove, general road foreman of engines, N. Y., N. H. & H., New Haven, Conn. Six members of the Executive Committee were elected. To serve for a two-year term are four: G. E. Anderson, general fuel supervisor, Grt. Nor., St. Paul, Minn.; S. A. Dickson, fuel supervisor, Alton, Springfield, Ill.; H. A. Malette, road foreman equipment, St. L.-S. F., Springfield, Mo., and W. D. Quarles, general mechanical instructor, A. C. L., Rocky Mount, N. C. For the one-year term were elected E. Holmquist, master mechanic, C. & N. W., Chicago, and W. J. Porter, fuel conservation engineer, L. & N., Nashville, Tenn.

T. O. Weeks Presents Chief Dispatcher's Views on Fuel Economy

In an address dealing with fuel economy from his viewpoint, T. O. Weeks, chief dispatcher-division trainmaster, Missouri Pacific, Little Rock, Ark., made a strong plea for a cooperative effort on the part of all persons having to do with train operation for the elimination of bad operating practices and for the purpose of conserving the will of all to do the best possible job.

"In discussing what we now know to have been a wanton disregard in past years for waste of fuel," he said, "bear in mind that what I have to say is in no way intended as a reflection on any group, nor as in defense of any group. On the contrary, that disregard was chargeable to all elements having to do with the operation of railroads. Fortunately, we did eventually realize that

fact—perhaps begrudgingly at first, but nevertheless with a growing realization that there did exist an unwarranted waste of fuel. At last we set about determinedly to locate and eliminate the causes, with astonishing results.

"Gratifying as those results have been, the fact that with each passing year we are able further to reduce fuel consumption is sufficient proof that while waste is not now quite so apparent, it does still exist.

"Too often supervisors through their acts, unintentionally of course, cause fuel waste, and unless we look back over our daily work in calm reflection, we may overlook many opportunities for eliminating that waste. It is of the utmost importance that we not only check up on the performance of those whom it is our duty to supervise, but that we also check up on ourselves with the utmost thoroughness of which we are capable. The thing that we took for granted last year, or last month, today may be found as wholly unsuited to operating conditions and perhaps is causing a waste that can be eliminated entirely."

Opportunities for Reducing Fuel Waste

Mr. Weeks here set forth a number of specific points at which he considers there are opportunities for effecting a decrease in the waste of fuel. Mechanical forces, he said, should not send an engine out unless it is in proper condition to perform efficiently. Only fuel of the correct standard should be supplied. Tenders should not be overloaded with coal so that some of it rolls off and falls to the ground.

Coming to the responsibilities of the division trainmaster-chief dispatcher, he listed as, first, keeping the mechanical forces informed what engines will be required and when they will be needed, and, second, that the chief dispatchers and yardmasters should maintain the closest degree of cooperation so that trains will not be ordered ahead of the time when they may reasonably be expected to move. Better planning at this point, he said, will eliminate a large amount of fuel waste resulting from trains not being ready to move when ordered. Further than this, he said, it is impossible to calculate how much fuel may be wasted as the result of the loss of enthusiasm and determination to do a good job which the crew suffers from standing around waiting for a train. This letdown, he said, may adversely affect the performance throughout the trip.

Work to be done by trains along the line should be planned by the dispatchers and the crews informed sufficiently in advance so that they, in turn, may plan their work. Switching, he said, should be done in the terminal and not on the road. Trains should be made up so that set-outs are in station order at the head end to eliminate unnecessary switching moves.

Through passenger trains should not be required to make local stops. To pick up a passenger with a $1.25 ticket by stopping at a cost of $5 is not economy, he said. For the same reason through-freight trains should handle only through cars.

"The stopping of through passenger or freight trains between terminals to take on fuel and water," said Mr. Weeks, "is one source of waste that can and should be eliminated. I have advocated this idea for the past 20 years and I shall continue to do so in the hope that eventually it will be eliminated. The Missouri Pacific has gone a long way toward that goal and I am sure will continue to work toward that end. A great many of our engines have been provided with increased capacity for fuel and water far beyond anything expected a few years ago. Auxiliary water cars are now in service on the majority of our through freight trains and by their use we have in many cases been able to eliminate as many as three water stops on a through freight run. . . . I know of nothing that has contributed so much toward improving train operation and consequent fuel saving as has the auxiliary water car."

Modern Facilities That Help

Mr. Weeks advocated the location of fuel-and water-station facilities so that locomotives can be served on the main track wherever possible. Detaching the locomotive from the train for a trip into the yard results in unforeseen delays. The installation of centralized traffic control had done much to eliminate bottlenecks on the Missouri Pacific, he said, and such installations are being extended.

A number of other methods which exert a favorable influence on fuel economy were listed by Mr. Weeks. He advocated increases in the mileages both of through and local runs, pointing out that these tend to decrease the number of hours on the road by eliminating or lessening the opportunities for overtime. Slow orders necessary in daylight working hours should not be allowed to remain in effect during the night as is frequently the case. The starting of tonnage trains when they will encounter the least traffic interference he cited as another opportunity where the dispatcher and yardmaster can cooperate in the interest of fuel economy.

The Dispatcher Needs Help

Upon the effectiveness of the train dispatcher's efforts depends in a large degree the entire program of efficient operation, he said. All employees in the operating department particularly look to him for guidance and assistance, and likewise he is entitled to full cooperation from each of his associates; without this he cannot succeed in assisting others to perform their work efficiently.

Mr. Weeks spoke of the important part traveling engineers and fuel supervisors could play in the education of engine crews not only in matters of mechanical operation, but in related matters of operating practice.

In conclusion he said that the task of eliminating fuel waste comes down to not being satisfied so long as we know that waste exists, constantly searching for its causes and then finding means of eliminating them.

"If we could only maintain our boyhood ideals," he said, "the enthusiasm that was ours the first day that we started out on our own to make a place for ourselves in the world; if we could supplement the knowledge we have gained through years of experience and hard knocks with those ideals and that enthusiasm, we might be inspired to pursue our activities with such zeal and determination that no obstacle could deter our progress.

"Improvements in society come about through the efforts of the idealistic realist who has the courage and audacity to challenge present usage with new ideas.

"It is true, and sadly so, that too often his efforts fail; however, for the most part, good is the result. Therefore, to progress we must experiment and for my part I had rather go down in defeat trying out something new that offers possibilities of improvement than to attain an easy success following a system of procedure that may have been entirely adequate yesterday, but is wholly inapplicable to the conditions of today."

How Much Locomotive Fuel Can Be Saved?

J. G. Crawford, fuel engineer, C. B. & Q., in a brief paper presented the results of estimates on how much locomotive fuel could be saved which were made by superintendents and master mechanics of the C. B. & Q. The information is presented in the following table.

The Percentages of Locomotive Fuel That Can Be Saved

(Estimates by C. B. & Q. superintendents and master mechanics)

Classification of fuel losses and fuel wastes:	Superintendents Range, Per cent From	To	Avg. Per cent	Master Mechanics Range, Per cent From	To	Avg. Per cent	Superintendents and Master Mechanics Avg. Per cent
Purchase, distribution and inspection	.00	8.00	1.87	.00	10.00	2.60	2.24
Handling of coal at coaling stations	.10	2.00	.43	.00	2.00	.60	.52
Handling of fuel oil at oiling stations	.00	.20	.05	.10	.20	.03	.04
Locomotive design	.00	14.00	4.02	.10	14.00	3.15	3.58
Locomotive maintenance	.00	3.00	.64	.00	1.50	.80	.72
Locomotive assignment	.00	1.00	.19	.00	1.00	.19	.19
Locomotive operation	.00	5.00	1.48	.00	3.40	1.41	1.45
Terminal locomotive handling	.00	1.00	.21	.00	.90	.36	.28
Time tables and dispatching	.00	10.00	1.71	.00	1.50	.45	1.08
Yard work	.00	.50	.22	.00	1.10	.23	.22
Road work	.00	5.00	1.26	.00	1.00	.16	.71
Passenger train heating and lighting	.00	1.00	.17	.00	1.00	.23	.20
Lubrication of cars	.00	5.00	.88	.00	3.00	.31	.60
Company material	.00	.40	.07	.00	.40	.07	.07
Repair tracks	.00	.10	.04	.00	.40	.08	.06
Signals and interlocking	.00	.50	.10	.00	1.00	.14	.12
Equipment	.00	5.00	.86	.00	.50	.18	.52
Loading of equipment	.00	.50	.08	.00	.25	.04	.06
Track	.00	5.00	.98	.00	1.00	.12	.55
Coal and water stations	.00	1.00	.18	.00	1.00	.25	.21
Total	...	...	14.40	...	...	11.84	12.62

"These investigations," said Mr. Crawford, "again bring out the extensiveness of the fuel problem and show where intensive effort should be applied to reduce fuel costs. Our individual members can, solely by their own efforts, accomplish little, but must obtain the support of other departments if minimum locomotive fuel consumption is to be reached and maintained.

"Is it too much to ask that all officers frequently consider operating problems in terms of fuel?"

Utilization of Locomotives

The report is made up of three parts. The first deals with the average daily mileage of locomotives on ten large roads. The second is a study of the highest average mileages made by groups of five or more locomotives reported by 35 railways. The third is a study of the cost of keeping surplus locomotives in service.

Average Mileages on Ten Highest Roads

For the first six months of 1940 the average miles per passenger locomotive per day on the ten roads with the highest records ranged from a high of 285.8 down to 198.8. A year ago the range was from 269.7 down to 205.1. Four roads showed decreases. The average for the United States is 189.1—an increase from 183.4 for the first half of 1939. All regions, except the Pocahontas, showed improvements.

In freight service the average daily mileages on the ten roads for the first six months of 1940 ranged from 129.3 down to 96.1 as compared with 124.1 to 95.2 for the corresponding period a year ago. The average for the United States was 105.7, as compared with 102.1 last year. All regions showed improvements.

In switching service the averages range from 79.8 down to 63.6; last year the highest average was 77.4 and the lowest 60. The average for the United States was 70.2 this year and 66.6 last year. All regions showed improvements.

To learn what the most active locomotives were doing the committee asked 35 of the principal railroads of the United States to pick out a group of 10 locomotives, or five locomotives if necessary and, for the month of May, 1940, give the average miles of this particular group, separating passenger, freight and switch service.

The roads each having a group of passenger locomotives averaging 10,000 miles or more a month are shown in one of the tables. These include Diesel engines as well as coal- and oil-fired steam locomotives.

In the freight-service table are included the roads on which the selected group of engines made 7,000 miles a month or more. In this group no Diesels are reported, so that the comparison here is between coal-fired and oil-fired locomotives.

The switch-service table includes only the groups of locomotives which averaged 3,500 miles or more a month, and in this group will be noted many Diesels. The engines are allowed 6 m. p. h., so that 4,464 miles means in service 100 per cent of the time.

Influence of Water Capacity

It was thought that water capacity would have a quite definite relation to miles per month, but in passenger service there were reported large tenders making 12,000 miles a month and practically the same size making 17,000 miles. There are 20,000-gal. tenders making 6,700, 7,600, 7,700, and 8,600 miles per month in freight service, and there is an indication that water capacity has some relation to miles obtained.

There is apparently no relation between water capacity of tenders and service performed by the switch engines each month.

Length of Runs

There are 600- and 1,400-mile runs in passenger serv-

Groups of Passenger Locomotives Making Greatest Mileage During May, 1940

Road	Whyte symbol	Tractive force, lb.	Diameter drivers, in.	Tender capacity Coal, tons	Oil, gal.	Water, gal.	No. locomotives	Length of run, miles	Avg. miles per locomotive per month Steam Coal	Steam Oil	Diesel
1	....	48,987	36	..	1,100	1,100	14	2,227	.....	.....	19,848
2	4-8-4	63,900	..	27	....	24,000	8	644	10,929	.....	.....
3	4-6-2	42,500	77	19	....	13,500	8	281	10,230	.....	.....
4	....	90,000	36	..	2,400	2,200	6	773	.....	.....	19,264
7	4-6-4	45,250	75	21	....	12,000	12	832	12,373	.....	.....
9	4-6-2	46,900	72	25	....	21,000	5	308	10,385	.....	.....
10	4-6-4	55,000	84	25	....	20,000	8	489	14,484	.....	.....
11	4-6-4	47,700	78	24	....	15,000	8	427	11,293	.....	.....
	0-4-4 + 4-4-0	108,000	36	..	....	.....	8	874	.....	.....	24,467
12	0-6-6-0	47,000	36	..	1,200	.....	5	1,084	.....	.....	22,268
13	4-6-4	50,294	84	25	....	20,000	5	421	12,358	.....	.....
14	4-6-4	58,200	80	26	....	16,000	4	269	11,405	.....	.....
20	4-6-2	42,750	73	..	4,850	12,600	5	675	.....	12,754	.....
22	4-6-4	44,000	80	16	....	18,000	10	157	10,963	.....	.....
27	0-6-6-0	50,600	36	..	....	.....	19	1,144	.....	.....	10,199
29	4-8-4	62,200	73	..	6,275	22,000	15	772	.....	11,088	.....
31	4-8-4	63,800	80	25	....	23,500	15	1,394	16,924	.....	.....
35	4-6-4	53,260	79	24	....	12,500	10	580	17,321	.....	.....

Groups of Freight Locomotives Making Greatest Mileage During May, 1940

Road	Whyte symbol	Tractive force, lb.	Diameter drivers, in.	Tender capacity: Coal, tons	Tender capacity: Oil, gal.	Tender capacity: Water, gal.	No. locomotives	Length of run, miles	Avg. miles per locomotive per month: Steam: Coal	Steam: Oil	Diesel
7	4-6-4	45,250	75	21	....	12,000	10	340	7,284	.....	.....
11	4-8-4	67,500	74	24	....	18,000	14	427	9,532	.....	.....
12	4-8-4	75,193	74	20	....	20,000	5	159	8,574	.....	.....
13	4-8-4	70,816	74	25	....	.....	5	914	9,389	.....	.....
14	4-8-4	72,000	74	26	....	16,000	15	259	7,738	.....	.....
15	4-6-6-4	105,000	70	26	....	20,000	10	295	7,294	.....	.....
18	4-8-4	66,400	70	30	....	20,000	14	271	7,680	.....	.....
20	2-8-2	63,900	61	..	4,000	10,000	10	...	....	9,116	.....
21	4-8-2	64,000	69	22	....	22,000	12	263	7,315	.....	.....
23	2-6-6-4	104,500	70	26	....	22,000	10	150	7,387	.....	.....
26	2-8-2	69,600	56	17	....	12,000	10	734	7,001	.....	.....
29	2-10-2	75,150	63	..	4,000	12,000	15	383	....	7,111	.....
31	4-6-6-4	97,400	69	22	....	19,000	15	427	8,571	.....	.....
34	4-8-4	70,817	70	23	....	15,000	5	367	8,022	.....	.....
35	4-8-2	73,020	69	28	....	15,000	10	300	7,468	.....	.....

ice with steam engines averaging 17,000 miles a month. In other words, with one group of locomotives, although the run is only 600 miles, it has been possible to average 17,000 miles a month, while with another group with a 1,400-mile run it is only possible to obtain 17,000 miles a month. The Diesels with 800-, 900- and 1,000-mile runs are making the highest performance of any motive power recorded.

Non-stop runs of 177 miles in freight service are fairly common. It will be noted that the length of the majority of the runs is short; 450 miles would cover nearly all of these. Yet, in spite of this, there are roads obtaining some 8,550 and 9,550 miles. One road, with a 900-mile run has next to the highest mileage obtained in any group of freight locomotives.

A long run is a very effective way of obtaining high mileage, but many roads are obtaining high mileage through turn-around runs.

Diesel and Steam

In passenger service the group of Diesel locomotives making the highest miles per month averaged 24,467 miles. The highest mileage group of steam locomotives averaged 17,363 miles per month. This group of Diesels —the best group we have been able to find—made 41 per cent more mileage than the best group of steam locomotives.

The service of the particular locomotives in the steam and Diesel groups has not been analyzed. This is the report as received from the railroads. Many times selected steam locomotives have made 20,000 miles a month, although we know of no group of steam locomotives that has made 20,000 miles a month. With the proper organization it should be possible to obtain the 20,000 miles a month from steam engines. If we went after the Diesels the way we are talking about lining up the steam locomotives, Diesel performance might also be improved.

In freight service there were not enough Diesels to give us a comparative figure, but in switching service we have an interesting comparison. There were reported five Diesels averaging 4,259 miles; they are the best group. Another road reported six switchers oil-fired, averaging 4,000 miles, and there was a group of five steam switchers coal-fired averaging 3,849 miles per month. The utilization of the oil-fired steam locomotives is 4.8 per cent greater than the coal-fired steam locomotives and the utilization of the Diesels 10.7 per cent greater than the coal-fired steam locomotives.

Finally, it would seem that the mileage obtainable from switching units is dependent on how long it is necessary to hold the unit for refueling, cleaning ashpan, or how long it has to be kept out of revenue service due to the condition of the locomotive.

Diesels can be fueled, I believe, at from two- to four-day intervals. The oil-fired locomotive probably will work a long period, and coal-fired switch engines should be coaled as necessary to keep the coal handy for the fireman. You will recall that switch engines have been operated 30 days without being taken off the job, where during lunch period it was possible to set the engine where the ashpan could be cleaned and the engine readily coaled, and, further, where water was so handy that the tender could be filled without further delaying yard operations. Is it fair to say here that very careful consideration should be given to coaling and other facilities for yard locomotives and that this strategic location is perhaps a major problem for every yard?

Cost of Surplus Locomotives

The report closed with an estimate of the cost of maintaining a locomotive in service when it could be stored and the utilization of the remaining locomotives increased. On the assumption of a pool of 40 locomotives, two of which could be stored, it was estimated that each of these locomotives would cost $6.10 a day for every

Groups of Switching Locomotives Making Greatest Mileage During May, 1940

Road	Whyte symbol	Tractive force, lb.	Diameter drivers, in.	Tender capacity: Coal, tons	Tender capacity: Oil, gals.	Tender capacity: Water, gals.	No. of locomotives	Avg. miles per locomotive per month: Steam: Coal	Steam: Oil	Diesel
1	....	49,060	40	..	400	....	41	....	....	3,988
2	....	75,570	40	..	600	....	2	....	....	4,065
6	0-8-0	49,691	51	11	....	6,700	5	3,849	....	....
9	0-10-0	62,950	51	20	....	10,000	5	3,542	....	....
10	0-4-4-0	36,000	38	..	....	....	5	....	....	3,517
12	0-4-4-0	50,000	40	..	600	....	5	....	....	3,800
13	0-4-4-0	29,750	40	..	....	....	5	....	....	4,259
14	0-4-4-0	50,000	40	..	400	....	20	....	....	3,804
22	0-4-4-0	49,300	40	..	600	....	7	....	....	4,147
26	0-8-0	52,990	57	..	3,018	8,828	6	....	4,032	....
28	0-6-0	39,100	51	12	....	8,000	7	3,653	....	....
32	0-4-4-0	50,000	40	..	600	....	10	....	....	4,289

day it remained in service when not necessary. This includes $4.30 a day as the cost of monthly, quarterly and annual inspections, which accrue on a calendar-day basis and for a full year aggregate an expense of $1,575 per locomotive. The remainder is a cost for fuel which is estimated to amount to at least $1.80 per day.

The report is signed by A. A. Raymond (chairman), superintendent fuel and locomotive performance, N. Y. C., Buffalo, N. Y.; H. W. Bates, assistant master mechanic, C. M. St. P. & P.; E. J. Cyr, division master mechanic, C. B. & Q., Chicago; E. W. Erisman, road foreman engines, Wabash, Decatur, Ill.; S. L. Forney, road foreman of engines, M-K-T, Parsons, Kan.; O. R. Pendy, general enginehouse foreman, N. Y. C. & St. L.; W. E. Sample, assistant to chief motive power and equipment, B. & O., Baltimore, Md., and E. G. Sanders, fuel conservation engineer, A. T. & S. F., Topeka, Kan.

Discussion

The use of the auxiliary water car to eliminate water stops was recommended and is a practice which is being followed on several railroads in the Southwest, including the Missouri Pacific and the Missouri-Kansas-Texas. It was suggested that the elimination of active engines might be carried too far; it would be better to keep an extra locomotive in service than to permit the smaller number of locomotives to operate without sufficient attention to keep them in top mechanical condition.

For the purpose of reducing the frequency with which locomotives have to be placed over the ashpit two possibilities were suggested. One was the blowing out of ashpans at selected points en route; the other was to find some means by which part of the coal space, when empty, might be used for the collection of ashes from the pan by some mechanical means.

Steam Consumption of Locomotive Auxiliaries

By E. E. Chapman

Mechanical Assistant, A. T. & S. F.

The proportion of steam used by auxiliary devices to the total generated on locomotives varies so much from day to day on the same territory, and averages on different territories vary so much that such a study can be attacked only in a general way.

The auxiliary devices that use steam on a locomotive may be listed in two classes of equipment; one, consisting of auxiliaries whose steam rate is independent of boiler output, and the other those auxiliaries related to steam generation, which have a steam rate proportional to total boiler output.

Among the auxiliaries in the first classification are the following:

1—Air pump.

2—Heating of mechanical lubricators and steam supply for hydrostatic lubricators.

3—Headlight turbo-generator.

4—Whistle.

5—Train steam-heat line. On modern passenger locomotives this is one of the larger items, and with trains using the steam-ejector type of air conditioning, it is a fairly constant load, but being heavier in summer and winter and lighter in fall and spring.

6—Axle generator loads. This is an indirect load, but since the generators driven by car axles increase drawbar pull by a definite amount, they may be considered as an auxiliary load, which reduces the net steam available for power propulsion of the locomotive and train tonnage.

The other class of auxiliaries which are related to steam generation consist of the following:

1—Boiler feed pumps and injectors.

2—Blow-off cocks, main and auxiliary, on foam-meter or continuous blow-off equipped locomotives. It is admitted that blow-off cocks remove water from the boiler rather than steam, but nevertheless, the water is at or near the saturation temperature of the steam so that a quantity of heat equivalent to approximately 20 per cent of the blow-off is lost by this auxiliary. Without blow-off, this heat would be available to further steam generation.

3—Safety valves.

4—Feed water heater.

5—Superheater.

6—Firing auxiliaries: (a) On oil burning locomotives, steam used to heat and atomize oil; (b) On coal burning locomotives, steam used to operate stoker engines and stoker jets, and grate shakers; (c) On either oil or coal burning locomotives, steam to exhaust nozzle or blower for supplying air necesasry to support combustion.

Steam Rates Independent of Boiler Output

Steam Used by Air Compressors—The steam used by air compressors is subject to wide variations, being dependent on number of cars in the train, condition of train line, frequency of stops and grade conditions. A check of steam consumption in comparatively recent tests showed an approximate consumption of 320 lb. of steam per hour in freight service on level territory, and 415 lb. per hour on mountainous grades. In passenger service steam rates to air pumps vary from 100 to 600 lb. per hour, the average being about 350 lb. per hour. The steam required by air compressors does not affect boiler capacity since generally the air compressors are working mostly at times when maximum demand of steam required at the locomotive cylinders is comparatively small. With train lines maintained in good condition, air pumps are working very little except when reducing speed or steadying train on curves, or when drifting on descending grades where air brakes are used to hold the train, or when coming to stops.

Lubricators—The steam required for heating mechanical lubricators or feeding hydrostatic lubricators is a relatively small quantity, which may be eliminated from any consideration as a drain on boiler output.

Headlight Turbo-Generator—The steam used by headlight turbo-generator and for train control is a varying quantity depending on the load on the generator. An average rate is approximately 260 lb. of steam per 1,000 watts load. In every day service, the headlight generator will use an average of approximately 100 lb. of steam per hour or from 0.10 per cent to 0.50 per cent of the total boiler output.

Whistle—The quantity of steam discharged by the locomotive whistle will vary with boiler pressure and is also dependent on the total time that the whistle valve is open. At 200 lb. boiler pressure the discharge is approximately 1.6 lb. per second, and at 300 lb. boiler pressure it is 2.3 lb. per second. Under average run-

ning conditions the whistle valve is open approximately five per cent of the time or three minutes per hour, so that steam used by whistle is 280 to 420 lb. per hour.

Train Steam-Heat Line—This is an auxiliary steam load of considerable consequence, whether it be used for train heating in cold weather or for air conditioning in warm weather. The average rate of using steam for heating or for air conditioning with the steam-ejector system is approximately 200 to 230 lb. per hour per car. In mild weather when the heating or cooling required is slight, the condensation loss in the line will amount to approximately 100 lb. per car per hour.

Axle-Generator Loads—Axle-generator loads are an indirect drain on boiler output. When used for lighting only, the average increase in drawbar output required amounts to 1½ to 2 hp. per car, which would be equivalent to a demand on the boiler of 30 to 40 lb. per car hour. On cars requiring power for air-conditioning equipment, the additional power load is equivalent to an average of 350 lb. per car hour for electro-mechanical equipment, and of approximately 120 lb. per car hour for auxiliary power equipment with the steam-ejector system. The latter figure is, of course, in addition to the steam taken directly from the boiler for the operation of the ejectors.

Steam Rates Related to Steam Generation

Injectors—The amount of steam used by injectors for boiler feeding is a fairly constant quantity for a given size injector, and will vary from 3,500 to 5,000 lb. per hour. However, all of the heat in the steam above that required for actually pumping water into the boiler against boiler pressure is returned to the boiler as heat in the feed water. The efficiency of the injector as a pump alone is not over two per cent, but as a boiler feed pump it is practically 100 per cent, so that net steam charged to the injector is negligible.

Boiler Feed Pumps—The quantity of steam used by boiler feed pumps varies from 2.0 to 5.0 per cent of total steam generated. The table below shows an average value at varying rates of boiler feeding:

Water evaporated lb. per hr.	*Steam to boiler feed pump*	
	lb. per hr.	*per cent of total*
25,000	750-1,350	3.0-5.4
50,000	1,350-1,450	2.8-2.9
80,000	2,200	2.75
100,000	2,350	2.35

The exhaust from the boiler feed pumps is usually turned into the feed water heater with a consequent recovery of a part of the heat in the pump exhaust. This will reduce the quantity of steam actually used by the boiler feed pump to a relatively small amount. It also reduces the quantity of steam recovered by the heater from the locomotive cylinder exhaust.

Feed Water Heater—The feed water heater is an auxiliary device on the locomotive which, instead of using steam from the boiler, reclaims part of the heat in the steam from the locomotive cylinder exhaust, and returns it to the boiler in the form of heat added to the feed water and the condensate returned either to the water tank or to the boiler, depending on the type of heater. The quantity of heat recovered by the feed water heater will vary from 7 to 14 per cent, and the quantity of condensate returned to the tank or to the boiler will vary from 5 to 15 per cent. Assuming that 2 to 5 per cent of the heat recovered is from the boiler feed pump exhaust, the feed water heater is responsible for a net gain of 2 to 12 per cent. By reducing exhaust pressure and reclaiming heat it permits greater output.

Superheater—The superheater is another auxiliary on the locomotive which produces a net gain in locomotive capacity. There is some loss due to a drop in pressure through the superheater. The drop in pressure will amount to from 6 to 25 lb. according to the velocity at which the steam is flowing through. The drop in pressure is more than offset by the increase in steam temperature to 600 to 750 deg. F. This increase in steam temperature is derived from heat in the flue gas. In addition to the gain in total heat by reason of the temperature rise, less of the superheated steam than saturated steam is used per stroke because of the higher specific volume, and the cylinder condensation is eliminated because exhaust temperatures are slightly superheated so that steam does not condense on the cylinder walls. The gain from the use of a superheater is about 20 per cent. However, the gain from additional heat extracted from hot gases is approximately only 10 per cent, the balance being represented by the benefits derived from greater unit volume of the steam and the reduction or elimination of cylinder condensation.

Blow-off Cocks—The heat in the water discharged through blow-off cocks is approximately one-fifth of the heat in the same quantity of water evaporated into steam. The quantity of water blown off over a given district may vary from zero to as high as 25 per cent of the water fed to the boiler. The latter figure represents the probably extreme where the boiler has been allowed to get dirty, and usually occurs when the blow-off on the preceding districts or runs was at or near the minimum figure. An average figure representing uniform operation over all territories would be from 5 to 8 per cent with a consequent equivalent steam loss of 1.0 to 1.6 per cent.

Safety Valves—With skillful firing, the loss of steam through safety valves is slight, varying from zero to one or 2 per cent. A general average for all locomotives would be approximately 0.5 to 0.7 per cent. This is not necessarily a drain on the boiler output because the discharge of steam through a safety valve is a positive indication that more steam is being generated than can be used, but it represents an unnecessary fuel loss.

Firing Auxiliary (Oil-Burning Locomotives)—On oil burning locomotives, the steam required for heating and atomizing oil varies from about 1.5 to 3 per cent, depending on the properties of the oil and the weather conditions. With oil of relatively low viscosity and in warm weather, the amount of heating is slight, but the heavy residuum fuel oils in cold weather may require the higher figure. The quantity of steam used is usually directly proportional to the boiler output and the average value is probably 2 per cent of boiler output chargeable to heating and atomizing.

Firing Auxiliary (Coal-Burning Locomotives)—The amount of steam required for stoker engines will vary from 0.5 to 0.9 per cent, depending on evaporation rate and grade conditions against which the stoker engines have to deliver coal from the tender to the firebox. The average for day-to-day operation is between 0.6 and 0.7 per cent of boiler output. The steam required by the stoker jets will vary from a minimum of 1.25 to a maximum of 3.25 per cent, again depending on the rate of firing, firebox size and grade conditions. The average quantity of steam chargeable to stokers ranges from 1.85 to 4 per cent of the total steam generated.

Exhaust Nozzle—Any discussion of the exhaust nozzle belongs properly to the Committee on Draft Appliances, but it must of necessity enter into this discussion since it is one of the most important auxiliary devices connected with steam generation, and thus may properly be included in this analysis. Only a small portion

Table I—Variables Assumed in Calculating Heat Balances

Operation, per cent of capacity	25.0		50.0		100.0	
	Freight	Passenger	Freight	Passenger	Freight	Passenger
Temperature, deg. F.						
Water to boiler..	180	170	210	200	225	220
Superheated steam	600	600	650	650	700	680
Smokebox	450	450	540	540	640	640
Exhaust steam...	250	250	280	300	320	350
Exhaust pressure, lb. gage	3.0	3.0	7.0	7.0	15.0	15.0
Excess air, using oil, per cent ...	50.0	60.0	30.0	45.0	10.0	25.0
Excess air, using coal, per cent ..	45.0	50.0	30.0	30.0	10.0	10.0
Ratio water to oil, lb. per lb.	12.2	12.1	12.0	11.9	11.5	11.4
Ratio water to coal, lb. per lb.	7.2	7.1	6.8	6.7	6.0	6.0

of the available energy in the exhaust steam is converted into useful work as velocity in the exhaust jet. Assuming adiabatic expansion at 12 lb. exhaust pressure, the quantity converted into velocity at the jet amounts to about 4 per cent of the total energy available. At 25 lb. exhaust pressure, the potential energy available if expansion were complete to atmospheric pressure would be about 6.2 per cent, but because at this initial pressure, expansion is not complete, the amount actually converted to velocity in the jet is still only about 4 per cent. The actual useful work done in moving gases through the front end and out the stack is 6 to 8 per cent of the energy converted to velocity so that of all the heat energy represented in exhaust steam, about 0.25 to 0.35 per cent is utilized in providing draft for the locomotive. However, it is considered that the equivalent energy in the quantity of steam used in providing draft is 4 per cent of the total exhaust steam as given above.

Summary

In order to summarize the foregoing, heat balances for two locomotives have been prepared. One of these is a freight locomotive of 100,000-lb.-per-hour steam generating capacity. The other is a passenger locomotive of 80,000-lb.-per-hour capacity. Heat balances have been calculated for operation at 25 per cent, 50 per cent, and 100 per cent capacity for each. Basic assumptions for both locomotives for preparing heat balances were as follows: Boiler pressure, 300 lb. per sq. in. gage, 98 per cent quality of steam, atmospheric temperature 60 deg. F., and temperature of water from tender, 60 deg. F.

For oil-burning locomotives, fuel oil was considered of 18,500 B. t. u. per lb. dry basis, containing 3 per cent moisture, 86 per cent carbon and 11 per cent hydrogen. For coal-burning locomotives, a fuel was assumed with 11,500 B. t. u. per lb., moisture 7 per cent, fixed carbon 50 per cent, volatile 32 per cent, ash 11 per cent, and sulphur included in the fixed carbon content, 2.5 per cent. Assumed variables are shown in Table I.

The information from the detailed heat balances is shown in Table II. These figures represent the probable extremes that are encountered with modern locomotives of good design.

Table II—Per Cent of Steam to Locomotive Auxiliaries

Operation at per cent capacity	As per cent of steam generated			As per cent of total heat in fuel		
	25	50	100	25	50	100
OIL-BURNING FREIGHT LOCOMOTIVES						
Steam to auxiliaries, not including that used for draft	7 to 10	5 to 8	4 to 7	4 to 7	3 to 5	2 to 4
Steam to auxiliaries including that used for draft ...	10 to 13	9 to 12	8 to 10	7 to 9	5 to 7	4 to 6
OIL-BURNING PASSENGER LOCOMOTIVE HANDLING 12 CARS						
Steam to auxiliaries, not including that used for draft	22 to 26	12 to 16	8 to 11	15 to 18	8 to 10	5 to 6
Steam to auxiliaries including that used for draft ...	25 to 29	16 to 19	12 to 14	17 to 20	11 to 13	7 to 9
COAL-BURNING FREIGHT LOCOMOTIVES						
Steam to auxiliaries, not including that used for draft	7 to 10	5 to 8	4 to 7	4 to 7	3 to 5	2 to 4
Steam to auxiliaries including that used for draft ...	11 to 14	9 to 12	8 to 11	7 to 9	5 to 7	4 to 6
COAL-BURNING PASSENGER LOCOMOTIVE HANDLING 12 CARS						
Steam to auxiliaries, not including that used for draft	23 to 27	13 to 17	8 to 10	15 to 18	8 to 10	4 to 6
Steam to auxiliaries including that used for draft ...	26 to 30	17 to 20	12 to 15	17 to 20	10 to 12	6 to 8

Discussion

Several questions were asked concerning the effect of loss of steam through leaks between passenger cars and what difference air conditioning had effected in the hauling of the train. Answering the latter question, Mr. Chapman pointed out that air-conditioning equipment added as much as 15,000 lb. to the weight of the car, depending somewhat on the type of equipment installed, and that this added to the traction power required for hauling the train; to arrive at the total effect the increased traction power must be added to the steam used to generate the power required to operate the air-conditioning equipment.

The No. 8-ET Locomotive Brake Equipment

The gradually increasing need for better control of the slack movement in long freight trains was anticipated long before the introduction of the AB type freight brake and since then these requirements have been under continuous study with the object of developing such an equipment. This development was carried along step by step under constant checking in laboratory and service experiments by both the manufacturers and the A. A. R. The final result was the No. 8-ET which has now been in daily service on a large number of new locomotives where the improved brake control features have met with universal approval.

The two most important new train slack-control features are the synchronization of the locomotive and car brakes with maintenance of leakage for the service application and the controlled rate of locomotive brake cylinder pressure development for the emergency application. The service application synchronizing feature is accomplished through the medium of a reduction chamber incorporated in the distributing valve which acts to retard the development of effective brake-cylinder pressure on the locomotive to agree with that on the cars and then permit it to increase at the same rate and to the same maximum value as that on the cars.

The service-application leakage-maintenance feature is accomplished by an automatic pressure-maintaining

device which is operative in the brake valve first service position. This device functions to prevent an excessive rate of brake-pipe reduction on the locomotive and head cars when a brake-pipe leakage condition exists and thereby assures a more uniform application of all brakes throughout the train than would otherwise be possible.

The emergency application feature is accomplished by providing means whereby the rate at which the locomotive brake-cylinder pressure develops during emergency can be controlled at a rate that will hold the front portion of the train stretched while effective braking power is being developed throughout the train. This function is necessary for the smooth control of long trains, but the equipment is arranged so that it can be instantly cut out when it is not needed in passenger or short-freight-train service.

A brief discussion of the features mentioned, as well as certain additional new features, is given in the following paragraphs:

Service Application

Present freight-train-handling rules on many railroads calls for the open-throttle braking practice or holding the locomotive brake released. If the closed-throttle practice is followed, the locomotive brake should not be permitted to apply during the initial reduction or at least not until the slack of the train has completed its adjustment. In most cases the engineman intends to comply with this requirement, but it sometimes happens that he will allow the locomotive brake to apply with the train brakes and subsequently release the locomotive brake with the independent valve. This procedure can cause severe slack action due to the development of effective braking power on the locomotive before releasing.

The outstanding improvement in the service function of the No. 8 over the No. 6-ET equipment is the brake valve first service position which can maintain against leakage while the brake-pipe pressure is being reduced.

Brake-pipe leakage is unavoidable and while it can easily be measured before the train departs from the terminal, it may change en route and the engineman can never be sure as to just what the leakage is. He, therefore, plays safe and handles the brake as though a maximum leakage rate existed at all times.

On the basis of having the leakage fairly uniformly distributed throughout the brake pipe length, the relation between A. A. R. leakage rate in pounds per minute and pressure gradient for a 150-car train is about as follows:

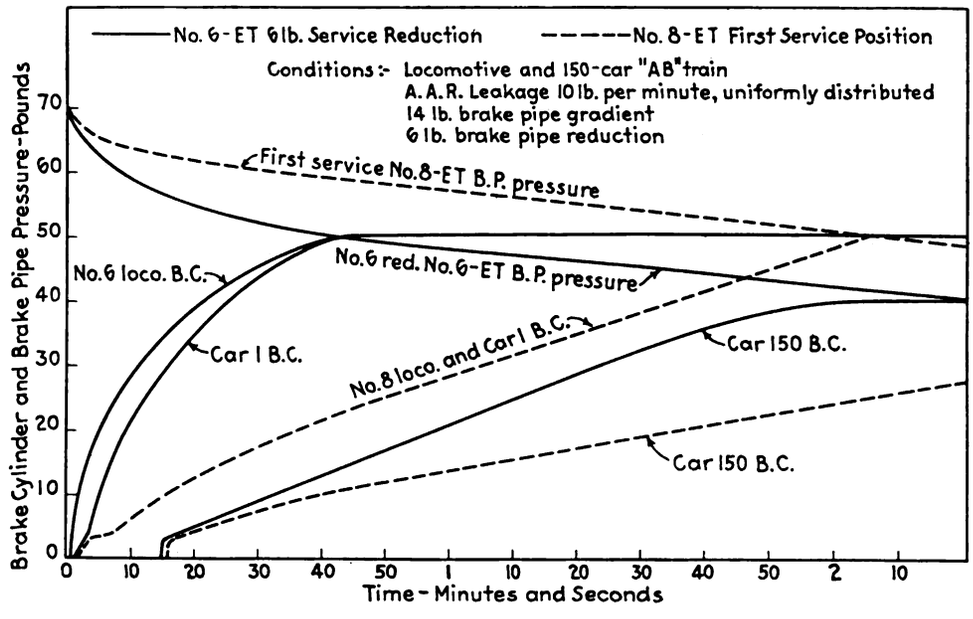
A. A. R. leakage	Pressure gradient
¼ lb.	½ lb.
2 lb.	2 lb.
5 lb.	7 lb.
7 lb.	10 lb.
10 lb.	14 lb.

The pressure gradient is an important factor because when the engineman attempts to start a service brake application by moving the brake valve handle from running through lap to service position, the air flow which is maintaining the leakage is suddenly cut off at the lap position. If at this time there is any considerable pressure gradient in the brake pipe, the pressure in the head cars will continue to flow toward lower pressure at the rear and thus cause a brake-pipe reduction at the head cars even before any service reduction can start. This flow of pressure from front to rear due to the pressure gradient is often called brake-pipe run-away and it usually causes a fall in pressure at the head end which is much more rapid than the normal brake application.

The effect of this pressure run-away is to cause the locomotive and head car brakes to apply much faster and much stronger than the engineman intends, with a result that a relatively heavy retardation is established in the head portion of the train before any brakes can become effective towards the rear. When this occurs and the train slack is stretched, the slack will close too fast and produce rough shocks in the rear portion of the train. This action is more pronounced at speeds under 20 m. p. h. and its degree is roughly proportional to the amount of pressure gradient existing when the brake valve was placed in the lap position.

The chart illustrates how the first service position with maintaining feature of the No. 8-ET locomotive brake equipment is able to meet this condition automatically without need of any special skill on the part of the engineman. It shows brake-pipe and brake-cylinder pressures plotted with respect to time when a minimum brake-pipe reduction of 6 lb. is made with the No. 6-ET equipment (solid lines) and a first service position reduction is made with the No. 8-ET equipment (dotted lines) on a 150-car train of AB brakes. The brake-pipe leakage of the train is 10 lb. per minute A. A. R. uniformly distributed to give a pressure gradient of 14 lb.

The two upper curves show how the brake-pipe pressure reduces from the instant of the brake-valve move-



A comparison of the reduction in brake-pipe pressure and rise of pressure in the brake cylinders at the head end of the train produced by the No. 6- and No. 8-ET locomotive brake equipments

ment at zero time throughout a total time of more than two minutes. The dotted line is for the first service and maintaining position of the No. 8 brake valve and the solid line is for the H-6 brake valve moved to service position long enough to make a 6-lb. service reduction and then moved to lap position. These two curves were obtained from actual tests of a 150-car train under the leakage condition described.

The lower curves which start from the base line give the brake-cylinder pressures for the locomotives, car 1 and car 150 for each kind of locomotive equipment. The large spread of cylinder-pressure values between the locomotive and rear car for the No. 6-ET (solid lines) as compared to that for the use of the No. 8-ET first service (dotted lines) shows why bad train handling with the No. 6-ET often occurs even when the leakage condition is not as severe as that shown here.

The preliminary service reduction of 7 lb. commonly employed with the No. 6-ET equipment to get train brakes applied before heavier brake applications are made, applies the engine brakes with about 17½ lb. brake-cylinder pressure, while the car brakes are applied with about 7¾ lb. This higher engine brake-cylinder pressure, which is roughly one-third of full service-engine-brake value, produces a greater degree of retardation of the engine as compared with the cars while train brakes are being applied, and, therefore, produces train slack action of more or less objectionable roughness, depending upon other governing conditions.

With passenger trains this frequently causes buffers and draft gears to be compressed and then, when the rear brakes apply and the platform buffers have an opportunity to recoil, an outward jerk occurs. When the head-end passenger-train cars are carrying a load, which results in a considerable reduction in the ultimate head-end braking ratio, this undesirable slack action is exaggerated.

The No. 8-ET equipment develops brake-cylinder pressure at the same low initial value as the car brakes and, therefore, the tendency of the locomotive to cause heavy inward slack action of the train at the start of a service application is reduced to a negligible amount. This is accomplished automatically.

Emergency Application

When an emergency application is made with No. 6-ET equipment, maximum emergency brake-cylinder pressure retarding forces are developed on the engine and tender as quickly as the distributing valve can supply air from the main reservoir. The unavoidable result of this with a freight train is to cause the engine to back heavily into the train, first gathering slack in a number of the head cars, after which the train slack closes one car at a time with increasing velocity and violence as the slack closure advances toward the rear of the train. This objectional result can only be avoided in long freight trains by so controlling the development of pressure in locomotive and tender brake cylinders that the engine will act to hold the slack stretched out in the front end of the train until the brakes at the rear of the train begin to apply.

The No. 8-ET equipment has a controlled emergency feature which can be set from the cab according to moderate or long freight train length so that this too rapid development of locomotive brake cylinder pressure and resultant slack action is avoided during emergency application with long trains.

The importance of the features described will in themselves justify the elimination of the No. 6-ET and substitution of the No. 8-ET on freight or passenger locomotives in road service. However, there are many additional valuable advantages.

A fundamental principle carried throughout the design of the No. 8-ET equipment is the maximum integrity for all functions. To this end pipe connections are strengthened with reinforced pipe fittings. Also, the greater facility for locating the equipment parts affords an opportunity to place the piping in a protected position and finally, these new features, added to the normal functional parts of the distributing valve, provide a factor of safety for the application and release functions which is not equalled by any other locomotive brake equipment.

The report is signed by G. H. Higley (chairman), general air-brake inspector, Erie, Cleveland, Ohio; R. E. Baker, general supervisor air brakes, air conditioning and power plants, B. & M., Boston, Mass.; J. Kane, enginehouse foreman, D. L. & W., Groveland, N. Y.; J. H. Glenn, traveling engineer, P. & W. Va., Pittsburgh, Pa.; Geo. Furgeson; H. P. Bender, mechanical engineer, P. & L. E., McKees Rocks, Pa., and J. Mutter.

Discussion

W. E. Vergan, supervisor air brakes, M-K-T, took up the advantages of the No. 8-ET equipment point by point and said that the same advantages were possessed by the modified No. 6-ET equipment with which a large number of M-K-T locomotives are equipped. He said, however, that his road did not need a brake valve designed to offset the effect of brake-pipe gradient. Trains on his railroad do not leave terminals with more than 3 lb. per min. brake-pipe leakage. He pointed out that the use of this equipment had begun as early as 1925 with the application of the pressure-retaining feature to the No. 6 equipment and that the other features had been applied from time to time before the No. 8-ET was brought out. In answer to a question later in the discussion, however, he stated that the No. 8-ET should be installed now by all means, but that it would not be advantageous to replace the modified No. 6-ET where it is now in service with the No. 8-ET.

The discussion, in general, indicated that the members consider the No. 8-ET equipment as having brought the locomotive brake up to the standards of the modern freight-car and passenger-car brakes.

Developments in High-Speed Braking

The D-22 Control Valve

The D-22 control valve with various lettered suffixes is now considered standard equipment for all new passenger cars; the electro-pneumatic straight-air feature may be added if desired and will cut the time required for service applications 75 per cent. If the braking power is to be in excess of the conventional 150 per cent, the speed governor is a necessary addition on all cars using the standard clasp brake.

When the speed of passenger trains exceeded 80 m. p. h. it became apparent that a new phenomena had to be dealt with in braking, which had not appeared at lower speeds, this was the bursting into flame of brake shoes when fairly heavy shoe loads were used at the higher speeds. This results in a very real fire hazard and also a very erratic friction curve which, under the right combination of speed and pressure, may give an unusually high friction value momentarily and slide the

wheels. To overcome this condition the American Brake Shoe & Foundry Co. designed a shoe with carbon blocks cast in the metal. This shoe reduces the flaming to a point where it is not dangerous and prevents sudden high friction peaks.

The principal shortcoming of the conventional brake when used on high-speed trains is the changing coefficient of friction, which varies from about .05 at 90 m. p. h. to about .25 at 20 m. p. h., which means that in order to obtain anything like a constant rate of retardation it is necessary to use extremely high braking power at high speed and provide an automatic means for reducing the cylinder pressure in steps, as the speed reduces; even with this arrangement it has not been practical to develop a retardation rate of over 2 m. p. h. per sec. until the speed is reduced to about 70 m. p. h., whereas the wheel-rail adhesion on a dry rail will permit a retardation rate of 3 m. p. h. per sec. or more at 90 m. p. h. if the braking power could produce it.

It is obvious that the highest rate of retardation permissible by wheel-rail adhesion, right from the instant the brake is applied, will give the shortest possible stop; to accomplish this the brake must produce a fairly constant coefficient of friction, and the adhesion between the wheel and rail must likewise be fairly constant.

The first problem has practically been solved by the automotive type disc brake.

Budd Brake Eliminates Pitching

The Budd disc railway brake* overcomes pitching of the truck upon application of the brakes because the two middle C-frame supports which exert a force tending to rotate the truck in a counter clock-wise direction, or in other words to raise the front end of the truck, exactly oppose or cancel out the forces acting on the truck center which try to rotate the truck in a clock-wise direction, or cause the truck to pitch downward. Therefore, since these two forces exactly balance each other, the truck stays level.

The result is a smoother brake application, with no spring windup to be suddenly released upon completion of the stop or the release of the brakes, causing a jerky uncomfortable stop.

Whereas the force reactions on a truck with the conventional braking system throw the front end of the truck down, when the brakes are applied, because the force of the outside brake hangers tend to pull the front end of the truck down, while they are equal to the force of the inside brake hangers opposing them, actually overcome the latter force by virtue of their longer lever arms.

The difference of forces would be enough alone to cause pitching but it is augmented as well by the forces acting on the truck center in the same direction. The combination of these two forces cause the truck to pitch forward until a stop is reached or the brakes are released, when the springs of the truck suddenly return it to its normal position, causing a jerky stop.

When the brake is applied air under pressure is admitted to the cylinders forcing the pistons outwardly from the cylinders, spreading the tongs which pivot about the fulcrum pins and squeezing the two shoes with their composition lining against both sides of the disc, just as though the disc were clasped with a pair of pincers.

The friction developed between this shoe lining and the disc stops the revolving disc and in turn the wheel to which the disc is securely fastened. In this manner nearly all of the heat generated by the application of the brake is thrown into the disc, which is so designed with openings and cooling fins as to carry this heat off quickly into the surrounding air, saving the wheels from wear and heat.

The only appreciable wear occurs to the brake-shoe lining segments and these can be readily replaced by new ones when necessary.

Wheel and Rail Adhesion

Quite a number of conditions effect the adhesion between the wheel and rail, such as water, frost, worms or insects, the humidity of the air, low rail joints, crossings and switches. At present the only means we have to overcome these things is to blow sand on the rail in front of the wheel. While this method is fairly effective at low speeds, it is of little value in the higher speed brackets, as very little if any sand actually gets under the wheel.

What is needed is some means for getting an abrasive (not necessarily sand) on the rail or wheel at high speed, which will be as effective as the present sanders are at low speeds. Even then the adhesion between the wheel and rail is reduced as the speed increases, due to the constant change of wheel load on the uneven rail surface. Any slight out of balance condition of the wheels sets up a dynamic augment similar to a locomotive driver and this also will change the wheel load at each revolution. All of this means that as train speeds increase it becomes more and more important to have a perfectly uniform rail surface, also perfectly balanced and perfectly round wheels, if a high rate of retardation is to be obtained at high speed. Unless this can be done the factor of safety, as it is affected by the ability to stop, will decrease in about a direct ratio to the increase in speed.

The Westinghouse Air Brake Company has now developed a practical device for preventing wheels from sliding. This device is used in conjunction with automatic cylinder-pressure control with clasp brakes or by itself with disc brakes.

The Operation of the Speed Governor and Decelostat

Referring first to the regulation of the brake-cylinder pressure through changes in speed. In view of the fact that the coefficient of friction between the metal shoe and the car wheel increases with the reduction in speed, it follows that ideally the brake-cylinder pressure should be regulated continuously downward to counteract this phenomenon. Actually it is not necessary to have the regulating device perform so precisely. From actual road tests, it has been found that it is sufficient to regulate the pressure from the maximum to the minimum in four steps and that a very close approximation to the ideal is secured thereby.

The means by which this desirable function is accomplished consists of a current-generating device that registers train speed through the medium of voltage change and electric relays that are tuned to react to the prevailing voltage at predetermined speeds and thereby bring about the desired regulation of brake-cylinder pressure.

The brake-cylinder-pressure regulating device, termed a differential relay, is electro-pneumatic in form and it is caused to function by the electric relays to regulate the brake-cylinder pressure in accordance with a predetermined plan. This plan, of course, is flexible and several combinations are in use today but the one most generally employed will be described here as representative of them all.

We have said that the maximum braking ratio with speed-pressure control is raised from the conventional of 150 per cent to 250 per cent of the car weight. This braking ratio prevails from top speed for the train down

* For a description of the brake developed by the Budd Wheel Company, see the article on General Pershing Zephyr, in the *Railway Mechanical Engineer* for May, 1939, page 169.

to 65 m. p. h. At approximately 65 m. p. h. the first speed-sensitive detector relay functions and the electro-pneumatic relay initiates a reduction in brake-cylinder pressure. If the stop is being made at the maximum contemplated rate, such as prevails with an emergency application, the first brake-cylinder pressure reduction is completed about the time the train speed is reduced to 40 m. p. h. At this point the second speed-sensitive relay functions and the differential relay now initiates the second brake-cylinder-pressure reduction.

The braking ratio during this time has been reduced to 150 per cent. At 20 m. p. h. the third and last speed-sensitive relay functions and the differential relay initiates the third brake-cylinder pressure reduction. The braking ratio is thereby reduced to 100 per cent and this value prevails to the stop.

By the same means the brake-cylinder pressure for stops from intermediate speeds is limited to the value that is suitable for the particular speed at which the application is initiated.

One striking example of the advantage of this plan of brake-cylinder pressure regulation is on the occasion of an emergency brake application by the conductor's valve at low speed, such as when starting out of a station.

Speed-Pressure Control

There are two plans for applying speed-pressure control, both of which are in use today. For trains which remain permanently coupled, two centralized speed-control units regulate the entire train. For trains that may have their consist altered, individual speed-control units are applied to each car. With the first plan, control wires are run from the centralized units throughout the train, and with the second plan, each car is a self-contained unit in itself. The second plan is obviously more flexible and the full benefit of the modern and powerful brake is always available in trains of any consist.

For wheel-slip protection the speed-control generator is used also for the protection of its particular axle and the same type of electric generator is added to each of the other axles of the train. Two of the electric relays used for speed-governor control are likewise given a dual function to perform and other electric relays of similar appearance and size, but different in function, are added to the relay panel. The electric relays used for wheel-slip protection are so constructed as to be responsive to a certain rate of change in speed.

There is no difficulty whatever in having these relays designed to ignore the rates of change in speed that are incident to normal stopping of the train, and yet infallibly recognize rates of change in speed incident to a wheel commencing to slip. For example, the normal retardation rate of a train is about 2.5 m. p. h. per sec., and it may reach under unusual conditions 5 or perhaps 5.5 per sec. On the other hand, a wheel slipping to a stop may reach a rate of deceleration of 100 m. p. h. per sec. The latitude this situation affords is so broad that we are free to select almost any rate we care to employ with our wheel-slip control relay. We have chosen the rate of 10 m. p. h. per sec., first, because it provides sufficient margin above the maximum train retardation rate to insure against unintentional functioning, and yet incipient wheel sliding is detected early enough to make possible the lowering of brake-cylinder pressure in time to avoid the wheel coming to a complete slide. In fact, we have taken graphic records of wheel retardation in actual road operation and have been fortunate enough to record graphically incipient wheel sliding, and in some cases the reaction of the wheel-slip controller was so prompt that it required careful analysis of the records to locate the change in the pattern produced by the wheel first slowing down and then resuming train speed.

This device is working very satisfactorily and makes it possible to brake up to the limit of wheel rail adhesion at all speeds without fear of wheel damage.

The question of the safety of this device has been raised. It must be remembered that, first, only one truck can be affected by any defect that might develop; second, if a train not equipped with decelostats should be on a greased track and the brakes applied hard enough to slide all of the wheels, the effective braking power would be about 20 per cent of that resulting if the wheels were still turning with a braking power just under the wheel-rail adhesion. To clarify this matter still further, let us assume that an emergency brake application is made on a rail which has been greased by a bad leak from an oil car; the cylinder pressure will go to 100 lb. and immediately all of the decelostats will operate and commence to dump the cylinder pressure as fast as the control valve can restore it; this cycle will take about 3½ sec. for the pressure to be reduced to 10 lb. and again be restored to the maximum. However, each time the cylinders are filled from the supply reservoir the pressure will drop about 2 lb. so that after several operations the cylinder pressure would be down to where the wheels would no longer slide and that pressure would hold to the end of the stop.

It must be remembered that during this time the pressure was never below 10 lb. and the average would be somewhere around 50 lb., or 50 per cent of the braking power of the train would be effective throughout the stop. As the cylinder pressure is reduced at each decelostat operation, the time required to restore it from 10 lb. to the maximum will be correspondingly reduced, so that a state of equilibrium will be reached sooner than would otherwise be the case.

The report was signed by H. I. Tramblie, supervisor of air brakes, C. B. & Q.

Discussion

J. P. Stewart, general supervisor air brakes, Mo.-Pac., said that the two high-speed trains on that road which are equipped with HSC electro-pneumatic brakes have operated successfully since early in March between St. Louis, Mo., and Omaha, Neb. The trains are equipped with speed-pressure control but not with the decelostat for the prevention of wheel sliding. So far, there have been no burned wheels. He said that in two instances the train parted and the stops were exceedingly short but smooth and there was no wheel sliding.

C. L. Eksergian, chief engineer, Budd Wheel Company, was called upon and discussed some of the elements affecting the rates of train retardation which it is practicable to attain. It is possible with automobiles, he said, to attain rates of 10 m. p. h. per sec.; in fact, rates as high as 15 m. p. h. per sec. can be reached. Such rates, he said, would not be practicable on cars where the passengers are permitted to move around freely. He referred to the investigation of the late Dr. Hirschfeld which developed that the passenger can stand a deceleration rate as high as 5 m. p. h. per sec., provided it can be built up smoothly and gradually through a period of, say, 3 sec. Another limitation is the adhesion between wheel and rail; fifteen per cent was about the highest which can be maintained at high speeds and this requires a well-worn rail. Some form of sanding on each truck, he said, would be required to effect a retardation rate higher than 3 m. p. h. per sec. A third requirement for maximum deceleration is a brake which will maintain a continuous maximum torque and a uniform rate of deceleration. Under these conditions he said that a stop from 102 m. p. h. could be expected in a distance of 3,290 ft. Two of the practical problems in braking, he said, are the transferring of the heat generated and the development of a quiet brake.

Oil-Burning Firing Practice—A Trip with the Fireman

The committee report is the first choice of five judges of eighteen competitive papers received from firemen as to their practice in firing an oil burning locomotive. This is written in the first person and in order of events.

The Trip Begins

We are called for a "hot-shot" mail train. After checking supplies, water level and noting temperature of oil we will now look at the firebox, looking for leaks and carbon and noting position of the burner. The burner is level, throwing a clear white flame, without dragging, against the middle of the flashwall, spreading evenly towards both back corners. In order to see the flues, syphon, crown and side sheets clearly, the fire must be adjusted to burn a clear white flame. This requires no little skill on the part of the fireman. The proper use of blower and atomizer is also called for. There is no carbon on the flashwall or bottom of the pan and no leaks in the firebox. The oil is the right temperature, we have a half glass of water and steam pressure is at the popping point, so here we go.

As soon as the engineer gets the train under way and makes his running test of air brakes, we sand the flues while the engine is laboring with the brakes set; in doing this, it might be necessary to shut down on the atomizer a little and close the damper some. This will insure the sand being sucked straight through the flues without any dropping in the pan and being thrown against the flashwall, thereby causing carbon to form.

Adjusting the Water Feed

Now that we have reached normal speed and have settled the boiler by the use of the blow-off cock and foam meter, the water level is beginning to lower. As she is steaming perfectly, we open the water pump another quarter-turn. From past experience we know that one-half turn is usually enough, although at times from one-half to a full turn is necessary. Sometimes with a heavy train the pump must be operated at full capacity, but always when increasing feedwater supply this should be done gradually to avoid over-pumping of boiler with subsequent drop of steam pressure. When opening the pump, the firing valve must, of course, be opened more to keep the steam pressure up.

We must watch the water level and steam gage closely and figure on any change in throttle or reverse lever positions and also be ready to make the necessary change in the firing valve. Should the steam lag a little we will sand the flues and if she does not pick up at once we will feel the fuel tank to see if the oil is hot enough, or open the heater a little more and adjust the atomizer one way or the other. We may have to ease off on the water pump a little to make her pick up.

Causes for Steam Lagging

Flues should only be sanded when the engine is working hard. Water should be kept at a safe level at all times and frequent use of blow-off cock and foam meter will keep water behaving nicely. If steam lags and no smoke can be obtained at the stack, the oil is probably too cold or there is an obstruction in the fuel pipe to the burner. This can be remedied by increasing the oil temperature or blowing steam back through the fuel pipe. We also look to see if cut-out valve on the fuel pipe under the deck or emergency valve have worked close. Sometimes the pump throttle may work open, causing steam to lag. If there is a sudden sucking sound at the firedoor, we know that the oil is too hot or some valve in the fuel line is closed. If this happens, we must act quickly. If there is too much color at the stack, we shall increase the atomizer a little at a time and perhaps ease on the firing valve. If at night and it is too dark to see the stack, we fire by the light of the fire at peephole in the firedoor. Nothing but experience and practice will enable one to become expert at this.

The correct amount of atomizer is very important. Too much atomizer will cause an annoying drumming noise and will also cause carbon to form on flashwall and is hard on the brickwork. When too little atomizer is used, the oil is not thrown against the flash wall with sufficient force to break it up and scatter it with the draft through the firebox and combustion chamber. Water should be drained from the oil tank at intervals, which can be done from within the cab on most engines.

We have one stop on this run and approaching it we shall fill the boiler enough to insure water in sight when the throttle is closed and the engine brought to a stop. The pump should be closed when the throttle is closed to avoid pumping cold water into the boiler. Steam pressure should be allowed to drop a little to prevent engine popping while standing.

We take this opportunity to look at the firebox and if any carbon has formed on flashwall we can easily remove it while hot, with a packing iron. If it is in the pan we get the chisel bar on top of the tank, chisel it out and blow out all loose carbon with the atomizer. The blower must be opened while doing this; to prevent flame from leaping out of firedoor, especially when re-lighting the fire. This is a point that should certainly be remembered.

Approaching Summits and Drifting

Approaching summits, where engine is to be drifted down grades, it is wise to fill boiler to such a level as will insure plenty of water in sight after tipping over the hill, or when brakes are set. Steam should be allowed to fall back so that the engine will not be popping while drifting. The fire should be cut down so as to hold boiler pressure a little below the popping point, and should be regulated so that steam pressure will not increase while drifting. Skill is required to adjust the atomizer properly so that a clear fire can be maintained without causing white smoke or gas to trail back from the stack. Too much atomizer will cause this, while insufficient atomizer will allow oil to collect in the bottom of the pan and drop, which may cause fires.

While drifting long distances if the water supply will permit, the boiler may be filled up and blown out enough to have her clean when the throttle is again opened. Also, blow-off cock and foam meter should be used frequently when the engine is working. This will insure boiler leg and mud ring being kept free from sludge which is constantly forming at these points. A clean boiler steams better than a dirty one.

After drifting a long distance, the firebox brickwork will, of course, cool off and the water heater will also cool off as the hot water is pumped out of it. When the engineer again starts working steam, we must know that the oil is hot enough and that steam pressure is at popping point. We shall have enough fresh water in the boiler so that we shall not have to open the pump for a while. This will enable us to get the firebox and water-heater properly heated without steam pressure falling back too much—then we can open the water pump as required.

Turning the Engine Over to the Next Crew

Approaching the terminal where we are to be relieved

by another crew, we have the oil hot and at least a half glass of water, and steam pressure near maximum so that relieving fireman can get away to a good start. Before getting off at the terminal we again look at the firebox, note the condition of the fire and see if any carbon has formed or any leaks developed in the firebox. The relieving fireman should be informed of any condition that might affect proper steaming or operation of firing equipment, such as lost motion in the firing valve, defective heater, steam leaks, etc. The engineer should also be informed so that he may so report them.

The report was signed by Roy W. Hunt (chairman), fuel supervisor, A. T. & S. F., Los Angeles, Calif.; L. E. Dix, fuel supervisor, T. & P., Dallas, Tex.; K. W. Muhl, road foreman of engines, Western Pacific, Stockton, Calif.; C. L. Schneider; S. R. Tilbury, fuel supervisor, A. T. & S. F., Topeka, Kan., and R. S. Twogood, fuel engineer, Southern Pacific, San Francisco, Calif.

Discussion

In general, the practice outlined in the paper was accepted by most of the members who took part in the discussion. Several points were emphasized, however. One is attention to the water level: it is important that it be kept high enough so that it will be unnecessary to continue the boiler feed after the throttle is closed. When standing by in cold weather it was pointed out that the slow oil movement permitted the pipe between the engine and the tender to get cold enough to make it impossible to feed oil fast enough when the engine started to work. It is at this time that it is necessary to use the blow-back to clear the pipe of the cold oil.

The use of a dial-gage thermometer to register the temperature of the oil in the tank was commended as an economy device, because of the men's inability to judge the temperature of the oil in the tank by hand. It has been found in stationary plants that a five-per-cent saving in fuel is effected by the use of this thermometer. Applying this percentage of saving to the fuel burned in a large modern locomotive, an estimate of $2,800 per year as a possible return on the installation of this instrument on the locomotive was considered reasonable by one speaker. In another instance a thermostat set at 180 deg. to control the admission of steam to the tank heater automatically is being used. This device was said to require occasional attention. The use of a dome on the oil tank to provide for expansion was recommended by another speaker.

In closing, Mr. Hunt described a dome about 10 in. high, about 3 ft. wide and about 6 ft. long which permits loading the tank with cold oil practically to its capacity without danger of overflow when hot. Concerning the use of special patented burners on which some comment had been made, Mr. Hunt said that boiler efficiencies obtained with the patented burners tested on the Santa Fe were about the same as the efficiency obtained with the old standard steam-atomizer type burners. In answer to a number of questions concerning the proper temperatures for oils of various viscosity and density, he recommended a chart used by the navy.

What Mechanical Cleaning Does to Fine Coal

Coal preparation methods are constantly changing with the increasing use of mechanical burning equipment. The increased use of mechanical loading machinery also necessitates changes in cleaning and other preparation methods. It is acknowledged that coal preparation is directly related to coal combustion and that the combustion efficiency of many coals is dependent in a large measure upon the efficiency of cleaning, size of coal and the equipment in which it is burned.

In recent years a great deal of experimental work has been done in stationary plants on the various sizes and kinds of coal having different burning characteristics. The result is that many mines are producing a number of secondary sizes from the 2 in. by zero or 1½ in. by zero nut and screenings coal. In some preparation plants it is not unusual to produce five or more secondary sizes from the 2 in. by zero coal without changing the screen plates. These separations may run almost any fraction of an inch. The demand for a clean fuel on the part of the domestic and semi-industrial stoker coal consumer has increased the production of dedusted and various sizes of pea and nut coal. The increasing market for the smaller sizes of coal is causing a decreased demand for the larger sizes. In fact some preparation plants ship no lump. Most new plants are provided with crushers and many old plants are installing crushers which will crush the entire tonnage to screenings if necessary.

There is an increasing trend towards mechanical cleaning of coal in the middle west and Rocky Mountain regions. The following is an average of several float and sink tests along with the average ash analyses from one district that has several different types of wet-washing equipment and these figures are based on good washing results. The sizes included in this check are 3½ in. by zero. The size 48 mesh by zero is discharged as refuse because many analyses show this size to contain an average of only 18 per cent of float substance and 82 per cent of sink substance. Raw coal, 3½ in. by 48 mesh, averages 16 per cent ash. Clean coal, 3½ in. by 48 mesh, averages 6½ per cent ash. Washing results at a specific gravity adjustment of 1.5 shows for clean coal a product of 98.25 per cent float substance and 1.75 per cent sink substance. The final refuse contains 5 per cent float substance and 95 per cent sink substance.

To the railroads as well as to the commercial consumer, mechanical coal cleaning has many advantages. Some of the advantages to the railroads are: More heat units per dollar; fewer cars required to handle locomotive coal; longer potential locomotive runs and, as a result, more miles per locomotive day; better fires, and less delay due to cleaning and dumping fires; lower cost of handling locomotives; decreased cost of grate and ash-pan maintenance; fewer steam failures due to honey-combing of flue sheets and clinkered fires; the use of commercially less desirable sizes of coal for stoker fired locomotives, such as 2 in. by zero or 3 in. by zero, with resultant benefit to the railroads due to a lower cost of handling such coal and of stoker maintenance. The mining companies benefit also by releasing to the commercial market the higher priced lump sizes of coal.

If coal is to meet the bitter competition of fuel oil, gas and electricity produced by water power, the consumer must receive more heat value per dollar from coal than from other fuels and must know that he is getting it. If the steam locomotive is not to go the way of the covered wagon, it must operate as cheaply or more cheaply than other forms of motive power.

The principal limiting factor in the operation of coal burning steam locomotives today is the necessity for frequent fire cleaning. Mechanical cleaning of coal is a progressive step in the right direction. The question that is asked many times, "Why should it be necessary to pur-

chase run of mine or sized coal up to a maximum of 6 in. or 8 in., then pass it through a stoker crusher, finally breaking it down to a maximum of 2½ in. to 3 in. before it enters the firebox? Why not purchase coal already broken down to the size desired for stoker firing?" There is only one answer to these questions. Raw screenings are dirty. The higher the percentage of screenings, the higher the percentage of impurities. In a desperate effort to get clean coal, the railroads must buy lump coal, or at least coal with as small a percentage of screenings as possible if the coal is not mechanically cleaned. Conversely, the screenings in mechanically cleaned coal is the cleanest part of the mine's finished product.

The higher speeds and more exacting requirements of present day railroad operation make it imperative that cleaner coal be furnished for railroad use, but not necessarily larger sizes of coal. On the contrary, as more stokers are installed in locomotives we may look forward to the time when no locomotive coal will be purchased in larger than 3-in. maximum sizes. That time will not come however, as long as screenings and dirt are synonymous in the minds of the great majority of purchasing and operating officers of the railroads.

The report was signed by S. A. Dickson (chairman), fuel supervisor, Alton, Springfield, Ill.; G. G. Ritchie, fuel service engineer, C. & O., Richmond, Va.; E. G. Sanders, fuel conservation engineer, A. T. & S. F., Topeka, Kan.; W. L. Sheppard, assistant to vice-president, Pittsburgh Coal Company, Pittsburgh, Pa.; W. R. Sugg, superintendent fuel conservation and lubrication, Mo., Pac., St. Louis, Mo., and W. J. Tapp, fuel Supervisor, D. & R. G. W., Denver, Colo.

Discussion

In answer to a question concerning a project for the treatment of coal to control the kind of clinker produced, Mr. Dickson said that research was being conducted on the possibilities of accomplishing this result at several points. He said that in this study clinker was classified as troublesome; that is, the kind which seals over and sticks, and trouble-free which is porous and does not stick. The research so far has developed that the sticky, sealing type of clinker usually possesses high density, while the porous, trouble-free type is of low density. He cited two examples, one a clinker with a specific gravity of 1.95 which is not troublesome, and the other, with a specific gravity of 4.16, which is troublesome. Changing the specific gravity of the latter type of clinker by adding other materials in the process of preparing coal for the market has been tried, and sand has been found the most practicable.

Coal Equivalents of Fuels and Power

In a report on the methods of collecting information for Form OS reports the committee on Fuel Records and Statistics circularized the chief accounting officers of 30 Class I railroads. The information sought related to the following four items: gross ton-miles of cars and contents—Form OS-E, Item 10; gross ton-miles of locomotives and tenders—Form OS-A, Item 5; coal equivalents of fuels and power—Form OS-E, Item 10, and allocation of locomotive fuel to yard service, freight service, and passenger service—Form OS-E, Items 2-07, 2-13, and 2-22. The following extracts are confined to that part of the report dealing with coal equivalents of fuels and power.

The average of the fuel oil equivalents and the B. t. u. values of the coals reported by the twenty-six roads shown in Table I is 161 gallons and 12,500 B. t. u., respectively. The individual fuel oil equivalents reported range from 71 per cent to 134 per cent of the average, and the individual B. t. u. values reported range from 82 per cent to 112 per cent of the average.

On the roads that use fuel oil only for lighting off coal fires, the oil equivalents used do not have so important an influence in the final fuel performance reported in pounds of coal per thousand gross ton miles as on the roads that use larger quantities as fuel to entirely replace coal on some of their locomotives.

The inconsistencies in the fuel oil equivalents listed in Table I are apparent, and study of the tables supplies some evidence to support the opinion that an average of 150 gallons, as the fuel-oil equivalent of a ton of coal, would not be far wrong. The committee, therefore, as a basis for discussion, advances the proposal that it would appear equitable for all railroads to use fuel oil equiva-

Table I—Item 10-01—Gallons of Fuel Oil Equivalent to One Net Ton of Coal

No. of roads	Gallons per ton	B.t.u. value of coal	Method of determination
1	R 115	11,150	Comparative service tests.
1	F 126	10,295	Comparative service tests.
1	R 127	13,800	On basis of B.t.u. heat content.
1	R 128	11,300	Comparative service tests.
1	R 137.5	11,500	Comparative service tests.
1	F 140	14,000	Comparative service tests.
1	R 147	11,300	B.t.u. content and thermal efficiency.
1	F 150	13,500	Data based on tests.
1	F 152	10,650	B.t.u. heat content.
1	F 156	13,500	B.t.u. heat content and combustion efficiency.
1	R 157	11,000	Service experience.
1	R 162	11,580	B.t.u. heat content.
1	F 166	14,000	Comparative service tests.
2	R 168	12,500	Comparative service tests.
1	F 168	12,700	Comparative service tests.
1	F 168	13,500	Comparative service tests.
1	R 168	11,000	B.t.u. heat content.
1	R 168	12,000	B.t.u. heat content.
1	R 168	12,600	B.t.u. heat content.
1	F 168	13,000	B.t.u. heat content.
1	F 184	13,700	B.t.u. heat content.
1	F 193.7	13,550	B.t.u. heat content.
1	F 194.5	13,500	B.t.u. heat content.
1	F 195	13,000	B.t.u. heat content.
1	F 215	13,500	B.t.u. heat content.
Averages	161	12,500	

F = Used for lighting fires only.
R = Used for fuel in road service.

Table II—Item 10-02—Kw. hr. of Electric Current Equivalent to One Net Ton of Coal

No. of roads	Kw. hr. per ton	B.t.u. value of coal	Method of determination
1	R 350	13,800	Comparative service tests.
1	R 380	11,300	Comparative service tests.
1	612	12,700	Comparative service tests.
1	R 720	13,500	Coal consumption per kw. hr. in company plant.
1	900	12,600	Coal equivalent of oil per kw. hr. in co. plant.
1	1,333	13,500	Relative B.t.u. values.
1	R 1,333	13,000	Coal consumption in Pub. Utility plant.
1	1,333	13,700	Coal consumption in Pub. Utility plant.
1	R 1,333	13,500	Coal consumption in Pub. Utility plant.
1	1,333	13,500	Relative B.t.u. values.
1	1,380	14,000	Coal consumption in pub. utility producing plant.
1	2,000	11,300	Relative B.t.u. values and locomotive efficiency.
Averages	1,084	13,035	

R = Electric locomotives used in road freight service.
Sixteen roads report, "No electric current used."

lents falling between the limits of 130 gallons and 170 gallons per net ton of coal.

The average kw. hr. equivalents of the three roads shown in Table II that base their determinations on comparative service tests of their steam and electric locomotives, presumably on the same runs, amounts to 447 kw. hr. per ton of coal. If the two roads that base their determinations on the fuel used per kw. hr. to produce the electricity in their own company plants are grouped with the three roads just mentioned, the kw. hr. equivalent of this group of five roads amounts to 592 kw. hr. per ton of coal.

If, on any identical locomotive run, we consider the replacement of steam locomotive power by electric locomotive power, assuming that equal ton mileage is produced by equal power expenditure at the locomotive drivers, we can arrive at a comparison of the coal consumption and the consumption of electric current for equivalent power production that may be considered to be of some interest in connection with this discussion.

Within the range of 3 lb. to 5 lb. of coal per hp. hr. for the steam locomotive, including standby consumption, which will embrace any ordinary operating condition, and assuming 90 per cent efficiency for the electric locomotive and a transmission factor of 80 per cent, the electricity purchased to produce work at the drivers, equivalent to the work produced at the steam locomotive drivers by a ton of coal, would range from 695 kw. hr. to 420 kw. hr.

Table III—Item 10-03—Gallons of Gasoline Equivalent to One Net Ton of Coal

No. of roads	Gls. of gasoline	B.t.u. value of coal	Methods of determination
1	15	13,550	Comparative service tests.
1	23.5	11,500	Comparative service tests.
1	25	11,150	Comparative service tests.
1	28.2	13,500	Comparative service tests.
1	30	11,000	Comparative service tests.
1	40	14,000	Comparative service tests.
1	40	11,300	Comparative service tests.
1	40	13,800	B.t.u. heat content.
1	41.2	10,295	Comparative service tests.
1	50	14,000	Comparative service tests.
1	50	13,500	Data based on tests.
1	50	12,500	Comparative service performance.
1	72	11,300	B.t.u. heat content and relative locomotive efficiency.
1	75	11,000	Comparative service tests.
1	175	10,650	B.t.u. heat content.
1	182	11,580	B.t.u. heat content.
1	192	13,000	B.t.u. heat content.
1	196	12,500	B.t.u. heat content.
1	196	13,500	Comparative service performance.
1	198.7	13,500	B.t.u. heat content.
1	202	12,600	B.t.u. heat content.
1	223	13,500	B.t.u. heat content.
Averages	97	12,420	

Six roads report "No gasoline used."

The committee considers that an equivalent value based upon such a strictly statistical comparison as that outlined above, is more consistent with the purpose of Form OS reports that an equivalent value based upon relative B.t.u. values or the coal consumption in public utility producing plants. Since the equivalent values are finally set up against gross ton mileage in the calculation of unit fuel performance in terms of pounds of coal per thousand gross ton miles, it would be natural to presume that a consistent equivalent would be one that would produce a fuel unit in pounds of coal per 1,000 gross ton miles of the same order of value as that produced on the same territory by steam locomotive operation.

Fourteen roads, shown in Table III, report values up to 75 gallons of gasoline per ton of coal. The average for these fourteen roads is 41.5 gallons per ton. The committee suggests that a range of 30 to 50 should be comprehensive enough for all practical purposes and that values within this range appear to be more consistent for statistical purposes than values outside that range.

Eleven roads, shown in the Road Service section of Table IV, base their Diesel fuel equivalents on comparative service performance, and have an average

Table IV—Item 10-04—Gallons of Diesel Fuel Equivalent to One Net Ton of Coal

No. of roads	Gallons of Diesel fuel	B.t.u. value of coal	Method of determination
			YARD SERVICE
2	15	11,000	Comparative service performance.
1	18.4	13,500	Comparative service performance.
1	20	11,300	Comparative service performance.
1	25	13,000	Comparative service performance.
1	25.5	11,500	Comparative service performance.
			ROAD SERVICE
1	16	13,550	Comparative service performance
1	20	11,000	Comparative service performance.
1	23	12,700	Comparative service performance.
1	29	11,150	Comparative service performance
1	33	11,000	Comparative service performance.
1	38	14,000	Comparative service performance.
1	44	11,300	B.t.u. content and locomotive efficiency.
1	46.5	11,500	Comparative service performance.
1	50	13,500	Data based on tests- fuel per hp. hr.
1	98	14,200	Comparative service performance.
1	98	13,500	Comparative service performance.
1	145	13,800	B.t.u. heat content.
1	160	10,650	B.t.u. heat content.
1	168	13,000	B.t.u. heat content.
1	181	12,600	B.t.u. heat content.
1	185	11,580	B.t.u. heat content.
1	194.5	13,500	B.t.u. heat content.
1	195	13,000	B.t.u. heat content.
1	215	13,500	B.t.u. heat content.

equivalent of 45 gallons per ton of coal. As in the case of the gasoline equivalent, your Committee would suggest that Diesel oil equivalents in the range of 30 to 50 gallons per ton appear to be more consistent for statistical purposes than values outside that range.

The report was signed by E. E. Ramey (chairman), fuel engineer, B. & O., Baltimore, Md.; G. W. Birk, supervisor fuel and locomotive performance, N. Y. C., Buffalo, N. Y.; P. E. Buettell, chief fuel supervisor, C. M. St. P. & P., Chicago; J. G. Crawford, fuel engineer, C. B. & Q., Chicago; H. Morris, superintendent fuel and locomotive performance, C. of N. J., Reading, Pa.; E. G. Sanders, fuel conservation engineer, A. T. & S. F., Topeka, Kan.; W. R. Sugg, superintendent fuel conservation and lubrication, Mo. Pac., St. Louis, Mo., and R. J. Tucker, assistant to fuel supervisor, C. & O., Richmond, Va.

Discussion

The report was presented by E. E. Ramey, fuel engineer of the Baltimore & Ohio. The discussion centered entirely around the troublesome problem of coal equivalents. J. G. Crawford of the Chicago, Burlington & Quincy, spoke at considerable length, pointing out that there was much unnecessary misunderstanding about these equivalents. It is quite impossible to have uniform or common conversion factors. Different conditions on different roads and changing conditions on any one railroad make it necessary to use different conversion factors and to revise them from time to time as conditions change. Because some railroads do not base these factors upon carefully compiled records of their experience, they are far out of line with the actual facts. He mentioned an instance in which a road was using a factor, which quite obviously was several per cent higher than it should be. E. G. Saunders of the Santa Fe said that the only accurate way in which to arrive at the equivalents is on the basis of comparative service tests. He suggested that the committee make further study to determine the proper methods of making such determinations on each road. In his opinion what is needed is uniformity as to the method of determining these conversion factors.

Mr. Crawford said that studies were now being made on the Burlington with a view to correcting the con-

version factors effective January, 1941. During the month of October each master mechanic was required to fill out a sheet for each locomotive unit, reporting for each day the points from and to which the locomotive unit operated, with the amount of fuel oil, gasoline or Diesel-fuel used; also the tons of coal which would have been used based upon experience on the division, the road foreman co-operating with the master mechanic in calculating this figure. On the basis of a consolidation of all of these reports for all the locomotives used during the month, it was believed that the most practical and satisfactory conversion equivalents could be established.

Coal-Fired Stationary Boilers

In its report the committee reviews the results of a campaign by one large railroad several years ago to reduce the fuel costs in its stationary boiler plants. This railroad burned 100,000 tons of coal annually, of which a saving of 18,000 tons was effected by a campaign to arouse the cooperation and interest of all officers, supervisors, and power-plant attendants, to develop correct power-plant and boiler-room practice, and, by a process of education to make all of these and others conscious of the cost of steam, compressed air, electricity and water, to make them aware of wasteful practices in the use of power. The report reviews the remarkable progress in fuel economy in public utility power stations, amounting to a reduction from 5.5 lb. of coal per kw.hr. in 1907 to an average of 1.41 lb. at present.

The report continues as follows:

On several railroads spreader type stokers have been found to be very satisfactory from the standpoint of operating economy, maintenance of stokers, furnaces, ash pits and contingent appurtenances. No difficulty is encountered in changing from one kind of coal to another, or, in burning the cheaper coals on the market. Further, wood mill refuse may be burned on these stokers in conjunction with the coal fuel and consumed economically. It has been found that ample furnace space or volume is essential to the satisfactory operation of spreader stokers, or from 1¼ to 1½ cu. ft. per b. hp. output expected of the boiler. Ample furnace volume, together with the absolute minimum of over-fire air, and as near a balanced draft as possible in the furnace, avoid trouble from fly ash and "carryover" of small coke particles. The use of simple, dependable automatic combustion control is necessary for good efficiency and as a guide to good economy.

The use of spreader type stokers also permits the satisfactory use of pre-heated air, which may be obtained by installing air preheaters and induced draft fans instead of large, tall chimneys. This practice will increase the over-all efficiency five per cent or more and without trouble or maintenance expense, by recovering heat from the flue gases which is otherwise lost. Another advantage of this type of stoker is that it may be installed as a replacement without the reconstruction of the boiler setting in most instances, usually making an economical and advantageous improvement, at much less cost than was possible with other types of stokers.

Coal is indispensable as a source of power and revenue for the railroads. The revenue on coal amounts to over one-fifth of the total freight revenue received by the Class I railroads. Obviously the railroads should be in the forefront in building and maintaining modern coal-fired stationary boiler plants.

It appears reasonable to state that a 20 per cent fuel saving can be made in railroad stationary boiler plants by installing modern steam generating equipment wherever possible, better maintenance of existing stationary boiler plants, and education of employes. A fuel saving of 20 per cent in railroad stationary boiler plants would amount to over $4,000,000 per year for all Class I railroads.

The report is signed by E. G. Sanders (chairman), fuel conservation engineer, A. T. & S. F., Topeka, Kan.; L. J. Owens; R. P. Dollard, shop engineer, C. & O., Richmond, Va.; C. Y. Thomas; W. J. Porter, fuel conservation engineer, L. & N., Nashville, Tenn.; W. J. Overmire, fuel engineer, C. C. C. & St. L., Indianapolis, Ind., and E. F. Allard, general fuel supervisor, C. & N. W., Chicago.

Turbine and Condensing Locomotives

Last year this committee, with the assistance of the Allis-Chalmers Manufacturing Company, and other manufacturers as listed at the end of the report, presented to this association a report covering a preliminary outline and design for a 5,000-hp. combustion-turbine locomotive.

This report is covered in the 1939 Proceedings of this Association, and in brief in the March 30, 1940, edition of the Railway Age, and the April, 1940, edition of the *Railway Mechanical Engineer*.

The Allis-Chalmers Manufacturing Company have also made a very extensive research in connection with a combustion turbine powered locomotive design for both electric and mechanical transmission, and presented this in the form of "An Engineering Study of the Combustion Turbine Locomotive" by J. L. Ray of the Steam Turbine Department. This report is dated September 6, 1939.

The latest report on the combustion gas turbine was presented at the 1940 conference of the Oil and Gas Power Division, Asbury Park, N. J., June 19-20, of the American Society of Mechanical Engineers, by Dr. J. T. Rettaliata, Steam Turbine Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

An earlier report was presented at the Mid-West Power Conference of the American Society of Mechanical Engineers, sponsored by the Armour Institute of Technology, Chicago, and held April 9 and 10, 1940. This paper was presented by Paul R. Sidler, Resident Engineer, Brown, Boveri & Co., Ltd., Baden, Switzerland. (Conference held April 9-10, 1940.)

The Allis-Chalmers Manufacturing Company are continuing their research and development of the combustion turbine and have built and are continuing to build more of them for the oil-refining industry.

Research has developed the fact that there are high temperature alloys which can be used for the combustion turbine blading which will permit use of temperatures considerably higher than 1,000 deg. F. now used for the combustion gas to the turbine. This will permit the economical use of higher pressures from the axial air compressor to the turbine and will materially increase the overall-efficiency.

Further than this, there are several other details of

design and construction which are being investigated and which it is believed will also improve the efficiency and operation of the combustion turbine, all of which will reduce the size and weight per horsepower. This size and weight reduction will permit a 6,000-hp. plant to be installed in one unit of a locomotive similar in construction to the one proposed in last year's report by this committee, except that instead of using two gas generating units and two 2,500-hp. combustion turbines, it will be possible to use four gas generating units and four 1,500-hp. combustion turbines, two gas generating units being located near each side of the locomotive cab with passageway between them.

With this arrangement, one complete 1,500-hp. gas generating plant and combustion turbine will form an individual power plant for each of the four pairs of driving wheels, each transmission being through hydraulic converter and hydraulic coupling the same as was proposed last year, except that last year each of the two 2,500-hp. plants was proposed to drive two pairs of driving wheels, making 5,000 hp. for each locomotive.*

With an individual 1,500-hp. power plant driving each of the four pairs of driving wheels, this power per pair of wheels would be three times as great as can be used on a single Diesel-electric locomotive driving axle because a 500-hp. electric motor is about as large as can be constructed in the space available on the Diesel powered locomotive truck. This makes it necessary to use 12 pairs of driving wheels for 6,000 hp. on the Diesel-electric locomotive, whereas, four pairs are sufficient for the combustion-turbine locomotive which would be constructed in one unit and one cab instead of three units and three cabs required for the Diesel-electric locomotive, which would weigh about 950,000 lb. compared with about 500,000 for the combustion-turbine.

The latter type locomotive would use Bunker "C" or No. 6 fuel oil (not distillate) and would use nearly double the amount of fuel used by the Diesel locomotive per horsepower developed, but the cost of the Diesel fuel oil would be double the cost per gallon of the fuel oil required by the combustion-turbine locomotive.

On account of its lighter weight, the combustion turbine locomotive would pull four 112,500-lb. cars or three 150,000-lb. passenger cars more than the Diesel-electric locomotive, or for handling the same maximum train as the Diesel, the fuel-oil cost would be an estimated 25 per cent less than for the Diesel-electric, and the cost of lubricating oil would be very much less than for the Diesel-electric locomotive.

One great factor in the statements given above is the use of the mechanical instead of the electric transmission, thus increasing the efficiency and making a considerable saving in space, weight, first cost and operating and maintenance costs, and above all permitting building a 6,000-hp. locomotive in one unit.

This report is signed by L. P. Michael, chief mechanical engineer, C. & N. W., Chicago.

* The efficiency of each of the smaller 1,500-hp. generating units would be slightly lower than for the larger 2,500-hp. units. The installation of four instead of two units, however, would permit using only the number of units required to handle the trains at a more efficient rating for both road and terminal operation of the train and of the locomotive alone.

Handling Coal Fires in Smoke-Restricted Territory

At the Terminal

The committee feels the horseshoe bank method is the best method of building fires with either high or low volatile coal.

As soon as possible after the fire has been knocked, the coal should be placed on the grates. The fire builder should place coal against and along the side sheets to a depth of 6 to 10 in. starting from the front and working back, filling the back corners well. If it is found that not sufficient coal has rolled to the center for lighting, enough coal should be added so that it will not be necessary to add coal during the steam-making period.

Lighting the Fire—If time permjts, the fire should be started in the center; use smoke consumer or portable air jet at the fire door. Turbulence and overhead air are very important; strong house blower line is also important. The roundhouse employees who handle this work must *specialize* in it. Otherwise the result will be enormous amounts of black smoke. The transportation department should give the roundhouse ample time to get locomotives ready.

Cleaning Fires—Fire cleaners should pull the fire to be saved to the center of the grates, leaving the sides and back corners bare. The bank is then placed on the grates and handled the same as when the fire has been knocked.

Care by the Engine Watchman—The watchman should not add to or disturb the bank; he should add only enough coal, through the center, to maintain a boiler pressure within 25 to 50 lb. of the maximum. If the locomotive is held long enough for the bank to burn down, enough coal should be added, through the center, to allow the bank to burn down to ash, after which another bank should be placed along the sides and back corners. When adding coal, the smoke consumer or stoker steam jet can be used to advantage, with the fire door partly opened. Each time the engine watchman gets on a locomotive he should open the blower for a period of three or four seconds to carry away the light ash that has accumulated on top of the bank.

Care of Fire by Hostler—The hostler, in moving the locomotive to the ready track preparatory to the crew taking charge, should use enough blower and add enough coal through the center to maintain boiler steam pressure within 25 to 50 lb. of maximum, with the fire burning properly. The smoke consumer or stoker jet can be used to advantage.

Care by Outside Hostler or Fireman—Taking the locomotive to the train terminal, the bank should not be disturbed and only enough coal added through the center with the scoop shovel to keep the fire in condition and work the boiler pressure up to within 5 lbs. of the maximum. Use the hook only when necessary.

Running Through Restricted Territories

Getting under way leaving terminals usually requires only the use of the two front and middle stoker steam jets with the stoker engine running as slowly as possible until the bank burns down to burning level. After that the two back corner steam jets may be cut in.

It is the opinion of the committee that objectionable smoke can be eliminated provided the engine crew are smoke conscious and use proper precautions in handling their locomotives and cooperate closely. Instructions thus far have been devoted almost exclusively to firemen but the engineman who uses the manufactured product, *steam*, can, by close cooperation with, and intelligent direction of, the fireman, make it possible to obtain the best results. A large proportion of the good coal and smoke records can always be traced to the engineman.

who, by intelligent interest in performing his duties, accomplishes smooth, steady running. On the contrary, if the engineer takes but little interest, the fireman will be compelled to take things as they are and may be blamed for the lack of skill or carelessness of the engineer.

Boiler feeding is an outstanding factor in coal and smoke performance, either good or bad. The most economical method of boiler feeding is to leave injector or feed water pump on continuously or as nearly so as possible and adjust feed to conditions of the run.

Selection of Fuel

The selection and preparation of fuel is still a debatable question. It has been definitely established that the low temperature portion of the volatile matter is the smoke-producing ingredient, and it has been discovered that the per cent of volatile matter in a coal material may be a very misleading criterion of the smoke producing properties of that coal material. Intelligent attention should be given to the selection of locomotive fuel from a smoke producing viewpoint. We cannot afford not to face the smoke nuisance. It is more than a nuisance—it is poison. The smoke peril will be poison to the bituminous coal industry, with a resultant loss in revenue to the majority of American railroads.

The report is signed by W. C. Shove (chairman), general road foreman engines, N. Y.. N. H. & H., New Haven, Conn.

Discussion

One suggestion was made that the stoker engine should never be shut off, but that a stoker throttle drifting position should be used which would keep the fire in good condition ready for the next up-grade without requiring heavy feeding and excess smoke after the locomotive again goes to work. Another member considered this impracticable on long down-grades where it would tend to build up the fire too much.

Reference to a comparative test on the New York Central of Clymer run-of-mile, Pittsburgh 2-in. by 4-in. egg, and Clymer briquettes lead to a lengthy discussion of honeycombing and clinkering. The test gave maximum evaporations at coal rates of 12,000 lb. per hr. of 75,000 lb. for the run-of-mine coal, 83,000 lb. for the Pittsburgh 2-in. by 4-in. egg, and 88,000 lb. for the Clymer briquettes. Difficulty was encountered, with honeycombing when burning the briquettes. This condition was improved by suspending a baffle arch from the crown sheet over the combustion arch which served to change the current of gas flow and prevent the precipitation of honeycomb on the tube sheet. This baffle was placed forward of the rear of the arch sufficiently so that the area between it and the arch was greater than the area over the rear end of the combustion arch. The results, however, were not conclusive. On one road which had tried the baffle arch in regular service the boilermakers objected. In this case the difficulty from honeycombing was eliminated by changing coal. There was disagreement as to whether or not honeycombing is always accompanied by moisture from small leaks in the firebox. Increasing the length of the combustion chamber was found by one road to have reduced the difficulty from honeycombing.

In closing the discussion Mr. Shove referred to the responsibility of operating-department officers for preventing smoke through smoke-restricted territories. It is important, he said, that all operating forces be smoke conscious in order to prevent smoke and that one superintendent can accomplish more by occasionally checking the smoke performance than can ten road foremen.

The Road Foreman and the Diesel-Electric Locomotive

By Leo W. Powell

Road foreman of engines, Atchison, Topeka & Santa Fe, Argentine, Kan.

Diesel-electric passenger locomotives have been in regular passenger service on the Santa Fe since May 12, 1936, and since that date have operated on regular schedules over the territory to which I am assigned:

At the present time we have five Diesel-powered trains in passenger service operating daily over my territory. In addition, the Diesel-powered Super Chief and El Capitan passenger trains are operated twice a week. The use of Diesel-electric switch locomotives was inaugurated on my territory August 17, 1939, and at the present time we have three Diesel switch locomotives assigned.

Character of Diesel-Electric Locomotive Control

It is necessary to educate enginemen and firemen in the handling and caring for Diesel-electric locomotives while in service. They must have a working knowledge of the operation of the Diesel engine, an electrical generator, control system and traction motors. Very few enginemen have had an opportunity to familiarize themselves with equipment of this nature. Necessary instructions are furnished by the builders of the Diesel locomotives and supplemented by railroad instructions. These instructions provide the opportunity for the enginemen and firemen to acquaint themselves thoroughly with this equipment, and to know the attention required on their part.

In any machine, the lack of lubrication is the most common cause for unnecessary trouble and rapid mechanical depreciation. Methods are provided for the periodical checking of the different parts of Diesel locomotives to avoid lubrication failures.

In train handling with Diesel locomotive, irrespective of the class of service, the throttle controls the power; the air brakes are handled in the usual manner to control the speed or stop; the reverse lever is used for setting the traction motors to operate in forward or backward direction. (This is an electrical change.)

One of the first and most important things the engineman must learn and remember is the proper handling of the throttle of a Diesel locomotive. There is considerable difference in the action that takes place in opening the throttle valve on a steam locomotive, to allow steam to flow to the valve chamber, and what takes place when the throttle is opened or closed on the Diesel locomotive. On the latter regulation of the speed is accomplished by varying the excitation between four pistons controlled by magnet valves. A combination of nine governor positions is possible, in the range from no fuel to maximum injection. These changes require a certain amount of time, and cannot be hurried.

Opening the throttle too far, while the train is moving slowly, results in a severe load on the mechanical and electrical equipment. If the throttle is opened too quickly, there is the possibility that the governor will not have a chance to adjust itself to the load and speed. The re-

sult is that the overspeed governor is very likely to cut in and stop the engine. Closing the throttle too quickly is likely to result in stuck or broken exhaust valves. It takes a short interval of time for the governor control to readjust itself to each throttle position, during which time the heavy rotating and reciprocating parts of the power plant must have a chance to slow down.

This is the reason for the instructions in road service to use at least four seconds in each notch in opening the throttle and at least six seconds in each notch while closing the throttle. The movements to each notch should be made quickly, with no stopping of the throttle between the notches. Diesel switch locomotives do not have notches on the throttle.

Many difficulties can be avoided by adhering to the proper operation of the throttle. By stopping the throttle between notches above Run 3 position, the governor control will have the engine all the way from idle to wide-open and back to idle.

Another important matter is the reverse lever. It should never be changed from one direction to another while the locomotive is in motion (except in an emergency). The reverser handle on the control station in the cab operates electric contacts which allow current to operate either the forward or reverse magnet valves on the reverser in the control cabinet when the electrical circuit is closed (no connection is made with the circuit open). This air-operated reversing switch changes the flow of current through the traction-motor fields, thus permitting the motors to rotate in the opposite direction.

If the reverse lever is changed to the opposite direction from what the locomotive is moving, it will consequently cause locking of wheels, with the possibility of damage to the gears or the sliding of wheels. Such a condition must be carefully watched and prevented.

Handling Passenger Trains

Handling of passenger trains with Diesel locomotives is similar, in some respects, to other forms of power. The starting of trains, however, consisting of all lightweight, all heavy, or mixed light and heavy cars, requires care in handling the throttle in Run 1 and Run 2 positions. Starting lightweight trains is simple for the reason that there is little or no slack in such trains. With the heavy passenger cars there is more or less slack in the draft rigging, and the throttle should be left in Run 1 position just long enough to take all of the slack in the couplers, then go to Run 2 position. It is characteristic of the Diesel locomotives that the traction motors develop their greatest drawbar starting effort when the locomotive is standing still. If the throttle is left in Run 1 position too long, while starting trains, it will some times result in stalling of one or more of the power plants. Care should be exercised in going to Run 2 position when starting trains consisting of heavy weight cars. If the slack is not taken out gently, the rear end will get a hard or rough start.

Now that we have the passenger train started and on its way, we have a condition with Diesel powered trains that does not prevail on steam powered trains. At our highway crossings, it is natural for the public using the highways to look for smoke emitted from a locomotive, and in this manner tell if a train is approaching. With the Diesel locomotive there is no smoke and little noise. Consequently there is more hazard and the engineman must see that the whistle is properly blown. The first blast should be started back far enough to compensate for the speed that is being made, and the last blast completed as the engine is on the crossing.

Speed is a watchword on our railroads today, and it is apparent it will increase. The speed recorder is essential and must be watched. On the Diesel locomotive, owing to the smoothness of riding, speed cannot be judged close enough by looking at the ground when approaching speed restrictions or stops. For that reason, there should be a standard location of station boards, crossing whistle boards, and speed restriction boards as to distance. This distance should be the same on all divisions on all railroads in this country, so that there could be no mistake made by any engineer as to distance required to slow his train down or to make a stop.

Instructions provide that the throttle must be reduced to Run 5 position when the train is to be steadied on a curve. When the speed of train is to be reduced by 15 mi. p. h., the throttle must be closed off to Run 1 position.

When the speed is to be reduced to 20 m. p. h. with 201-A type engine and 28 m. p. h. with 567 type engine, or a stop is to be made, the throttle should be closed to idle position.

When drifting or passing over railroad crossings, the throttle must be reduced to Run 1 position, which will hold the contactors in parallel position. If the throttle is closed to idle position, it will be necessary to open it to Run 7 position on a 201-A type engine and to Run 8 position on a type 567 engine to get back into parallel position.

If by chance the engineman gets into idle position while drifting or passing over a railroad crossing, do not open the throttle to Run 1 position, with the thought that it should be in Run 1 position over the crossings. This brings the series contactors back in, which is detrimental at high speeds. Leave the throttle in idle position until such time as the crossing is passed over, then open up to Runs 7 or 8 positions (according to the type of engine) so as to get parallel contactors back in. Then, if Runs 7 or 8 positions are unnecessary to make the schedule time, reduce the throttle to the desired position. Do not fail to observe this feature.

Freight-Train Handling

In freight service with the Diesel-electric locomotive of 5,400-hp. capacity, care should be taken that the brakes are fully released before starting. Caution should also be used in opening the throttle, as it has been proved these locomotives will start whether the train does or not. Trains can be broken in two, unless instructions are adhered to.

On heavy grade when the locomotive is operating in the parallel position, and full power is desired; in order to avoid stopping of the engines by the overspeed governor during transition from parallel position back to series position (when speed drops back to 19 m. p. h. with 201-A type engine, and 28 m. p. h. with 567 type engine) close the throttle quickly to idle position; remain in this position four seconds to allow power switches to drop back to series position. Open the throttle quickly to Run 5 position, and then open throttle from Run 5 position to Run 8 position in the usual manner. If Run 8 position picks the speed up and it is desired to negotiate heavy grades with the contactors in series position, it is necessary to reduce the throttle.

Controlling Switching Movements

In yard switching, the Diesel-electric locomotive gives very good service. My observations cover all classes of yard work: heavy lead switching, industry work, and transfer work.

The yardmen and enginemen soon become familiar with the handling of the Diesel locomotive. We all know the yardmen working with steam power, switch cars by

the exhaust of the engine. The Diesel locomotive changes this, and the yardmen have to watch the cars, however, the proper handling is soon learned.

The yard engineman can save at least 20 per cent in the stopping distance, if the yardmen are out far enough from the side of the cars to be observed, so the engineman can use one hand on the throttle and the other hand on the brake valve. If the engineman is only using one hand to handle first the throttle and then the brake valve, they will move two or three car lengths farther before the cars separate. The Diesel locomotives drift as good or better than the cars. This is not the case with a steam locomotive, for when it is shut off the pistons act as a brake and will pull the slack out before the brakes are set on the steam locomotive.

Diesel engines come up to their maximum speed within a few seconds and there is available full tractive force through the electrical system. Quick acceleration results. Standby losses are small.

Yardmen favor the Diesel locomotive because there is no exhaust steam or smoke blowing down on the leads to interfere with their signals, nor ice forming on the leads in the winter from the injector overflow. The engine crew's visibility is very good, and this is a very important factor in a busy terminal where a large number of trains, engines, and signals must be observed.

Yardmasters can place the Diesel locomotives on any job. There is no need to think of the wheel arrangement, or the road number when the smaller old industry tracks have to be pulled or a car spotted. The Diesel will go any place a freight car will clear. The Diesel locomotive will also make transfers, making it unnecessary for the yardmaster to wait until a certain type locomotive returns from another job to make the delivery. It will go out on a lead and give very good service. The Diesel locomotive is ideal yard power.

The helper's duties on Diesel locomotives include maintaining correct temperatures and oil pressures, cleaning purolators, and blowing down steam generator.

Discussion

Several members were inclined to question the desirability of the two-hand method of operating Diesel-electric switching locomotives. This had resulted in sliding wheels in a number of cases, and instructions have been issued on some roads to use one hand, first on the throttle, second on the reverse lever, and third on the brake valve to overcome this difficulty. Mr. Powell said that in his experience he had had no difficulty of this kind —the brake-cylinder pressure does not develop fast enough to cause trouble.

There was general agreement among those who took part in the discussion that an important factor in training enginemen for Diesel-electric locomotive operation is to discourage them from attempting to make repairs or adjustments. Three other phases of training in which the road foreman plays an important part were set forth as the handling of the controls, encouraging thorough cleaning of the units, and helping the men to cultivate sensitiveness to unusual sounds and judgment in observing and reporting symptoms of disorder. Questions concerning the comparative cost of maintenance of steam and Diesel locomotives developed no information.

In closing, Mr. Powell said that maintainers accompanied the road locomotives on the Santa Fe and that, therefore, they had little difficulty with the enginemen attempting to make adjustments. The fireman, he said, served as a helper to the maintainer. In reply to a question he said that, while the road men bid in Diesel jobs on a seniority basis, they had to qualify before going out on a run.

Report on Interchange and Billing

(*Continued from page* 486)

from first receipt of car on home lines if this would result in charge being outlawed before one year.

Question—Defect card marked "Labor only" is issued to cover forged carrier iron secured by two short bolts in place of carrier casting secured by rivets. In the event of wrong repairs being corrected within nine months of first receipt of car on home lines, but more than a year after date of wrong repairs, can bill be made for the rivets?

Answer—Yes. If the wrong carrier iron had been secured with rivets, bill could not be disputed. Consequently, Rule 87, Sec. (a), would not apply insofar as the twelve months' limitation is concerned and bill for rivets is proper.

Rules 88 and 107, Items 290-A to 293—Question—When wrong repairs are corrected on authority of defect card marked "Labor only," and labor allowances in Rule 107 include certain items of material, should any deduction from the specified labor allowance be made?

Answer—No. In view of the fact that no deduction is made in material prices which include the labor of application when work is performed, e. g., angle cock renewed in connection with air-hose renewal, brake shoes renewed in conjunction with brake-beam renewal, it would appear consistent to make full labor charge even when such charge includes material.

Rule 98, Sec. (g)—Question—A pair of wrought steel wheels is removed at location R&L 2, and standard steel wheel gage gives the following readings:

	Rim thickness, in.	Condemning limit, in.	Movable pointer, in.
Wheel L2	29/16	1¼	2/16
Wheel R2	28/16	1¼	4/16

Billing repair card shows the following service metal to correspond:

	Before turning, in.	After turning, in.
Wheel L2	17/16	15/16
Wheel R2	21/16	17/16

In view of the fact that there is a loss of 4/16 in. of service metal in turning wheel R2 to full flange contour, is it the intent that this amount will be deducted from wheel L2, thus reducing the service metal on this wheel to 13/16 in. and crediting both wheels with only 13/16 in. service metal?

Answer—Second par. of Rule 98, sec. (g), specifies that the amount of service metal on *both* wheels will be governed by the minimum amount on *either* wheel. Note 2 specifies *that the amount of service metal after turning shall be determined by deducting the greater amount of loss on either wheel from the amount of service metal on each wheel before turning.*

In the absence of any statement in Note 2 to the contrary, it must be assumed that this note is to be applied in conjunction with the second paragraph. Consequently, as the greater amount of loss is 4/16 in., this must be deducted on both wheels, making the service metal on wheel L2 13/16 in. As the second par. of sec. (g) specifies that the amount of service metal on both wheels will be governed by the minimum amount on either wheel, it is proper to credit wheel R2 with 13/16 in. also.

Rule 99—Question—Wheels are changed account slid flat (handling line responsibility) at location R&L 2, at which time journal bearings are not renewed, but the old bearings reapplied. Three days later, on same road, a new journal bearing is applied at L2, account hot box and journal bearing worn out. Is charge against car owner proper for this new journal bearing?

Answer—No. Arbitration Decision No. 1049, which, according to Circular DV-978, is still in effect, states that charge against car owner is not proper under such circumstances.

Rule 101, Item 188—It is felt that the present price for truck spring caps on the basis of Item 188 of Rule 101 is not equitable, and your committee recommends that this question be referred to the A. A. R. price committee for review, and the possible setting-up of arbitrary prices for these items.

Reason—Information reaching the committee indicates that most railroads are purchasing these items, the cost of which is greater than the corresponding per pound price allowed in item 188.

Rule 101. Note Preceding Item 250—Requests were received from several sources to consider the credit allowances provided in the above note for various types of non-approved friction draft gears. The information presented indicates a general opinion that the credit allowances specified are excessive, on the basis of actual condition in which some of these gears are being found when removed from service.

Recommendation—The committee recommends that the A. A. R. price committee be requested to make a thorough study of these allowances.

The report is signed by M. E. Fitzgerald (chairman), master car builder, C. & E. I., Danville, Ill.; D. E. Bell, (vice-chairman), A. A. R. instructor, C. N., Winnipeg, Man., Canada; E. G. Bishop, general foreman car department, Illinois Central, E. St. Louis, Ill.; A. C. Browning, assistant to secretary, mechanical division, A. A. R., Chicago; W. J. Burns, mechanical inspector, General American Transportation Corporation, Chicago; C. A. Erickson, general A. A. R. inspector, C. & N. W., Chicago; B. F. Jamison, assistant supervisor car inspectors, Southern, Birmingham, Ala.; F. McElroy, chief clerk-vice-president, Union Tank Car Company, Chicago; J. E. Mehan, assistant to superintendent car department, C. M. St. P. & P., Milwaukee, Wis.; C. A. Mick, mechanical inspector, C. B. & Q., Chicago, and H. E. Wagner, general car foreman, Mo. Pac., Dupo, Ill.

Discussion

The discussion of this report was extensive and well adapted to clarify questions which were raised regarding many suggested changes in the rules. It was pointed out that the rule interpretations and changes mentioned are in no way official but merely suggestions for the consideration of the A. A. R. Mechanical Division, for possible inclusion in the official Rules of Interchange.

The report was accepted and recommendations ordered submitted to the A. A. R.

Maintenance of Tender Cisterns

(*Continued from page* 471)

patches make the best job. When large patches are necessary a suitable electric-welded butt-strap should be applied to the water side.

On the Vanderbilt or semi-Vanderbilt type cisterns we find that vertical splash plates or bracing extending the full diameter of the tender or semi-circular in shape, with suitable cut-outs for surging of water make the best type of bracing. In some cases a horizontal member, similar to the box-type bracing in rectangular cisterns, is used.

It is the general consensus of opinion that riveted splash plates or bracing to tee or angle irons make the best application, although a few roads specify bolts in place of rivets. Some roads at the present time are experimenting with ¼-in. alloy steel for splash plates. These have given satisfactory service although it will be a matter of years before any definite decision can be reached.

The cast-steel water bottom with tender frame cast integral has been used on a number of roads and has proven very successful. This application has been used on rectangular, Vanderbilt and semi-Vanderbilt cisterns.

Recommendations

In conclusion it is recommended that vertical staggered or box-type bracing be used on all large rectangular-tank cisterns together with cast-steel water bottoms and that tee or angle irons and bracing be of riveted construction. On the Vanderbilt or semi-Vanderbilt it is recommended that vertical splash plates or bracing be used together with cast-steel water bottoms.

Inspection—Cistern should be thoroughly inspected at specified intervals, both exterior and interior. The inspections should consist of the following at each washout or thirty day period: Cistern to be filled with water to detect any leaky condition prior to draining. When draining cistern note flow of water from tank hose to see that it has a normal flow. Examine all splash plates or bracing, angle or tee irons for cracks or loose rivets and other defects. Examine all safety appliances such as ladders, grab irons, steps, manhole cover plates and hinges, etc. Examine tank screens and tank valves, stoker compartment, stoker supports, stoker trough, stoker slides, coal gates and hinges and anchor bolts for securing cistern to frames.

Cleaning—After necessary repairs have been made to the interior of the cistern it should be thoroughly cleaned using washout hose, if necessary, at each boiler-wash or thirty-day period. All foreign matter such as cinders, mud, scale or dirt is to be removed. Clean out tool boxes and clothes lockers, also cinders and coal from the back of the cistern.

Prevention of Rust and Corrosion of Coal and Water Spaces—The majority of roads report that they are using a protective coating of non-corrosive paint or special product to help decrease the corrosion of coal spaces of cisterns. While we cannot arrest the action of water and chemicals in fuel we can to a certain extent prolong the life of these sheets by using any one of the following preventatives: Paint sheets with red lead, black cement paint, roof cement, Continental cement, fibre cement paste, No-Oxide, or black box-car paint. Very few roads use any preventative in the water spaces due to the fact that treated water has helped to eliminate pitting and corrosion to a certain extent.

The report is signed by L. R. Haase (chairman), district boiler inspector, B. & O., Baltimore, Md.; A. T. Hunter (vice-chairman), assistant general boiler inspector, A. T. & S. F., La Junta, Colo.; W. A. McKeown, locomotive inspector, Bureau of Locomotive Inspection, I. C. C.; R. A. Culbertson, district boiler inspector, C. & O., and A. A. Stark, general boiler and mechanical inspector, Lehigh Valley.

Discussion

One member in discussing tender maintenance said that some roads use ⅜-in. plate with ½-in. rivets for the tender bottoms and in his opinion better results would be obtained if they used ½-in. plate with ⅜-in. rivets in this location. On another road where tenders with cast-steel water bottoms are used, the splash plates are made in the form of bulkheads. All the surging of the water must take place through the water bottom; the only opening in the splash plates being a small one to relieve the air pressure.

Allied Railway Supply

Exhibit Breaks Record



J. W. Fogg,
President-Elect

FROM the point of view of companies represented, as well as diversity of products displayed, the exhibit of railway equipment and supplies, held in conjunction with the co-ordinated railway mechanical association meetings at the Hotel Sherman, Chicago, October 22-25, inclusive, apparently surpassed all previous records. The exhibition, sponsored by the Allied Railway Supply Association, included most of the important devices and materials associated with both locomotive and car construction and operation and was highly educational in character. Practically all of the meetings of the various associations, which included the Railway Fuel and Traveling Engineers' Association, the Car Department Officers' Association, the Master Boiler Makers' Association, and the Locomotive Maintenance Officers' Association, were adjourned by 3:30 p. m. each day to give the members ample opportunity to inspect and study the exhibits.

A total of 114 railway equipment and supply companies contracted for exhibit space and 17 companies were represented as non-exhibitors.

New Officers Elected

On the third day of the convention, the Allied Railway Supply Association elected the following officers for the ensuing year: President, J. W. Fogg, MacLean-Fogg Lock Nut Company, Chicago; first vice-president, C. F. Weil, American Brake Shoe & Foundry Co., Chicago; second vice-president, F. W. Venton, Crane Company, Chicago; third vice-president, M. K. Tate, Lima Locomotive Works, Lima, Ohio; fourth vice-president, E. H. Weaver, Westinghouse Air Brake Company, Wilmerding, Pa.; fifth vice-president, B. S. Johnson, W. H. Miner Co., Inc., Chicago; sixth vice-president, J. J. Cizek, Leslie Company, Inc., Lyndhurst, N. J.; secretary, J. F. Gettrust, Ashton Valve Company, Chicago; treasurer, J. J. Cizek, Leslie Co., Inc., Lyndhurst, N. J.

The following were elected to serve on the Executive Committee: John Baker, Locomotive Firebox Company; Richard Welsh, Nathan Manufacturing Company; R. A. Carr, Dearborn Chemical Company; V. W. Ellet, Hunt-Spiller Manufacturing Company; C. O. Jenista, Barco Manufacturing Company; F. C. Hasse, Oxweld Railroad Service Company; Joe Sinkler, Joseph Sinkler, Inc.; W. Lane, Franklin Railway Supply Company; Bard Browne, Superheater Company; W. C. Sanders, Timken Roller Bearing Company; C. R. Busch, Unit Truck Corporation; Russell Walsh, Ewald Iron Company; J. E. Buckingham, Portable Equipment Company, and Thos. O'Leary, Johns-Manville Sales Corporation.

Supplementary List of Exhibitors

The main list of exhibitors and a floor plan showing the space locations were published in the *Railway Mechanical Engineer* for October, 1940, pages 395 to 398. The following is a supplementary list.

EXHIBITORS NOT SHOWN IN THE OCTOBER ISSUE

Ace-Everseal, Chicago.—Piston-rod and valve-stem metallic packing. Represented by G. V. W. Roth and E. A. Winears. Space 171.

American Steel Foundries, Chicago.—Drews Evertite side bearing; sleeve brake-beam head; brake-beam fulcrums; Simplex snubbers and springs; clasp brake forgings; assorted steel pins and bushings; models of railway trucks; models of A. S. F. roller-bearing units. Represented by C. E. Grigsby, S. M. Goodrich, W. B. Martin, T. H. Parke, W. S. Spieth and J. W. Van Natta. Spaces 160 and 161.

American Throttle Company, New York.—Locomotive throttle. Represented by Bard Browne.

Brake Equipment & Supply Company, Chicago.—Reception booth. Represented by Jack Alberson, B. Pratt, J. F. Pratt and C. J. Smith. Space 259.

Buda Company, Harvey, Ill.—Car jacks, locomotive jacks, car replacer. Represented by R. M. Blackburn, H. H. Cohenour, R. B. Fisher, F. L. Gormley, Sr., W. A. Hart and R. K. Mangan. Spaces 248 and 249..

Detroit Graphite Company, Detroit, Mich.—Cemtex cement-coating paint for box-car interiors to eliminate hide and fertilizer odors. Represented by A. P. Fields and L. F. Flanagan. Space 257.

Flannery Bolt Company, Bridgeville, Pa.—Locomotive boiler staybolts; electrical testing implements; application tools. Represented by R. W. Brown, E. S. FitzSimmons, G. R. Greenslade, W. C. Masters, J. H. Truschel and W. M. Wilson. Spaces 80, 81, 82, 113, 114 and 115.

Ford, J. B. Sales Co., The, Wyandotte, Mich.—Metal-cleaning compounds specialized for the back-shop cleaning of locomotive parts, coach interior and exterior washing, also locomotive washing. Represented by H. J. Perry, R. W. Renton and C. S. Tompkins.

General Refractories Company, Philadelphia, Pa.—Reception booth. Represented by J. T. Anthony, F. d'Olier, Jr., and T. M. Mulderig. Space 258.

Safety Car Heating & Lighting Co., New York.—Automatic railroad coach window. Represented by E. K. Goldschmidt, E. F. Leherissey, C. A. Pinyerd and G. H. Scott. Spaces 277 and 278.

Spring Packing Corporation, Chicago.—Spring journal-box packing and lubrication devices. Represented by W. M. Gibbs, J. P. Landreth and John T. Landreth. Space 247.

Ulster Iron Works, Dover, N. J.—Represented by E. Kavanagh and N. S. Thulin. Space 279.

ADDITIONAL INFORMATION ON COMPANIES LISTED IN OCTOBER

Arrow Tools, Chicago.—Small forge tools and safety retainers. Represented by M. W. Benedict and H. J. Trueblood. Space 201.

Boss Bolt & Nut Company, Chicago.—Boss lock nuts; water-tite bolts; flat-head car bolts; nut locks; common bolts and nuts. Represented by R. J. Mulrooney and J. B. Whitenack. Space 280.

Ewald Iron Company, Louisville, Ky.—Tennessee charcoal bloom staybolt iron; Laurel engine bolt iron; hammered Tennessee iron billets; hammered Laurel iron billets. Represented by F. P. McEwen, J. Kuhns and W. R. Walsh. Space 229.

Gilg, Henry F., Pittsburgh, Pa.—Samples of tool steel. Represented by I. H. Jones and R. E. Surtees. Space 213.

Globe Steel Tubes Company, Milwaukee, Wis.—Locomotive flues; superheater flues; boiler tubes. Represented by J. W. Floto, G. H. Krohn, F. J. O'Brien and C. A. Schroeder. Spaces 158 and 159.

Hanna Stoker Company, Cincinnati, Ohio.—Models of Hanna Stokers Type S-F and H-4. Represented by C. A. Alexander, E. A. Averill, W. T. Hanna and C. D. King. Spaces 36, 37, 66 and 67.

Reliance Machine & Stamping Works, New Orleans, La.—"SPEE-D" high-pressure grease appliances for locomotive connecting-rod lubrication. Represented by H. C. Manchester and G. A. Pettit. Spaces 292 and 293.

NON-EXHIBITING MEMBERS

Allied Railway Equipment Company, Chicago.
American Brake Shoe & Foundry Co., Chicago.
Baldwin Locomotive Works, Philadelphia, Pa.
Brubaker & Bros. Co., W. L., Millersburg, Pa.
Byers, A. M., Pittsburgh, Pa.
Cardwell-Westinghouse Company, Chicago.
Economy Arch Company, St. Louis, Mo.
Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.
International Nickel Company, Inc., New York.
Leslie Company, Inc., Lyndhurst, N. J.
Magnus Metal Corporation, New York.
Midgley-Borrowdale Company, Chicago.
Miller Heating Company, F. W., Chicago.
National Tube Company, Pittsburgh, Pa.
New York Air Brake Company, Watertown, N. Y.
Texas Company, The, New York.
Waugh Equipment Company, New York.

The EDITOR Looks at

The Conventions

Start Meetings on Time

Much valuable time is lost if the meetings are not opened sharply on schedule. Such time could be used to advantage in visiting the exhibit or attending to other business. It speaks poorly for an association when the officers are not in place and ready to do business at the announced time. Members dropping in become restless and wander out if there is no evidence that the proceedings are about to begin. It is just as important to run meetings on time as it is to keep trains on schedule. One reason why many members do not show up promptly is that because of lax conditions they have come to discount the programmed times. This should be corrected!

An Active Advisory Board

Sometimes advisory boards or sponsoring committees are appointed for window dressing purposes. Not so the advisory board of the Locomotive Maintenance Officers' Association. When it was attempted a few years ago to rehabilitate the old International Railway General Foremen's Association there was little left to work with. Two years ago, when it was decided to change its name to more clearly define its objectives, it was recognized that heroic measures were necessary. The situation was faced frankly and with determination. For one thing, it was felt that sympathetic interest and help would be necessary from higher up, and an advisory board was appointed. This board has not only been generous in giving help and advice, but its members have put their shoulders to the wheel and have taken an active part in the conventions. They have done this freely and cheerfully in the belief that there was a real and crying need for an organization of this sort. It is not to be wondered at that they received so enthusiastic a greeting at the luncheon given in their honor.

Mission of Guest Speakers

Guest speakers—men in high official positions or outstanding leaders in related fields—do much to enhance the prestige of the associations. More important than this, however, is the very practical contributions they make. The members of the four associations, highly trained in their peculiar specialties, are naturally deeply engrossed in them—so much so that they may lose sight of railway operations or problems as a whole, and fail to appreciate their proper place in the "picture." Addresses from guest speakers are inspiring, but their value may be measured by the extent to which they give their listeners a better appreciation of how they can work more intelligently in the interests of their own railroad as a whole, or the railroads collectively. From this point of view the associations were especially fortunate in their selection of guest speakers this year.

Manual for Procedures

As one studies the efforts of the associations to improve their programs and make their meetings more effective, it would seem desirable to bring together the best and most approved practices in the form of a simple manual. It should not be a large or voluminous affair, or it may not be read and studied. Possibly it might consist of only a very few simple, but really vital items. To start with, it should be divided into at least two parts: (1) how to select committees and get real and effective committee service; (2) a half dozen "musts" which should be observed in arranging for and conducting meetings. While there is a certain continuity in official leadership, the presiding officers change each year and a little coaching, in the form of simple rules, will certainly not be out of place. Close observance of a half dozen of them would do wonders in improving some of the meetings.

Conservation of Human Resources

One of the major objectives of the Railway Fuel and Traveling Engineers' Association is the conservation of fuel. In the consideration of the various aspects of this objective the thinking of the members is directed to the quality of the fuel, to the character of the equipment in which the energy in the fuel is released and converted into useful work, and to methods and practices best adapted to preventing waste in the use of fuel. These material and routine aspects of fuel economy monopolize so much of the members' attention that when a practical railroader stood before the convention and talked about the conservation of human energy and enthusiasm as a necessary prerequisite to the conservation of fuel in the day-in and day-out operation of the railroad, he made a profound impression on every person in the room. Ordering trains in advance of practicable departure time is a well-established source of fuel waste. What is seldom emphasized by supervisors, however, is the loss of the will to do a good job, which poor or careless planning causes when crews are allowed to "cool their heels" in terminals. It was evident by the emphasis throughout his address that T. O. Weeks, the Missouri Pacific chief dispatcher-division trainmaster, who spoke at the fuels session on Friday

morning, October 25, is one supervisor who considers the effect of this loss of even greater ultimate consequence than its immediate effect on the coal pile, bad as that may be.

Fuel conservation has long been the subject of concern by the railroads. Its systematic study and the organized attack to which it is now subjected must be credited directly to one of the predecessors of the present association. In the course of the 32 years since the organization of the International Railway Fuel Association, the groundwork of organization and methods of dealing with the physical aspects has been laid. One problem still remains, however, which has received so little systematic consideration that, from the association viewpoint, it is a pioneer field. That is the conservation of the human resources of energy, enthusiasm, capacity for cooperation, loyalty. This is one of the factors of fuel conservation. But it is just as much a factor of the safety movement, of the drive to reduce maintenance expenses; in fact, it is a factor in every effort to do a better, cleaner-cut job of railroading. It is a job, the significance of which escaped the old generation of driving supervisors. Its significance still escapes too many officers and supervisors, even today. It is a problem, continued pressure on which requires the inspiration of imagination, and deep human sympathy. It presents a worthy challenge to the pioneer spirit to which the speaker referred in his closing remarks.

Every Railway Employee a Public Relations Representative

Colonel "Bob" Henry astonished his large audience at the joint assembly of the mechanical associations and the Allied Railway Supply Association. The dramatic picture that he unfolded of the place of the railroads in our national economy and their problems in dealing with the public, will not soon be forgotten and, judging by the many individual forceful comments after the meeting, promise to bear real fruit. Every employee should be a public relations representative, doing his part in helping to educate the public as to what the railroads are doing in the public interest and what their problems are. If every one of the million railway employees—about one of every 130 of our population—would function in this way, there would be no public relations problem, at least in the terms in which we think of it today. General Manager J. M. Symes of the Pennsylvania Western Lines, also drove this point home at the close of his address before the Car Department Officers' Association.

Roundhouse Foreman's Job

Undoubtedly when John M. Hall, director of the Bureau of Locomotive Inspection, prepared his address for the Locomotive Maintenance Officers' meeting, he visualized speaking to a comparatively small group under prosaic auspices. His astonishment was quite evident when he found himself at the center of the speakers' dais, with a luncheon audience of half a thousand. His prepared address was pointed, and yet tactfully expressed in accordance with his usual good statesmanship. But he didn't pull his punches in his interpolations. For instance, at the very outset, before he got down to his carefully prepared manuscript, he handed out this one:

"It is to our sorrow that there are some railroads in the United States today that are expecting the roundhouse foreman to put in 12 and 13 hours a day on the job. I cannot conceive of a man who has worn himself down day after day, hot-footing through the roundhouse and through the shop, if he has one, and then how he can expect to sit down and do constructive thinking. Many railroads have gotten away from that and I hope for the benefit of their service, not only for the benefit of these roundhouse foremen, many of whom will be higher officers in time, that they will see the light and give these men a reasonable period of work."

This accords with the evidence developed in the campaign conducted in the columns of this publication a few years ago, although there has been marked improvement on most roads since that time.

Ability to Express Yourself

The effectiveness of a meeting depends largely on the ability of the members to express themselves clearly and concisely. As a matter of fact, the ability of a supervisor in these days can be gaged to a certain extent, at least, by the same measuring stick. A well-known railway executive recently held an audience of a thousand or more almost spellbound as he discussed certain phases of the railroad problem. We have been told that when he became an executive not so many years ago, he had little if any ability as a public speaker. He made a study of public speaking, practiced diligently at it, and now rates high as an after dinner speaker. Whether in a convention or a small staff meeting, a man's prestige and effectiveness can be greatly enhanced by cultivating the ability to stand on his feet and speak clearly and logically. A great professional organization, the American Society of Mechanical Engineers, for years at its annual meetings has tried to get all of the speakers and presiding officers for the day together before the sessions start to receive simple and practical suggestions that will help make their performances more effective.

Building Memberships

The strength of an association depends on the scope of its membership, the practical value of its meetings, the number of members actually engaged in promoting its activities, and the publication of proceedings which will broadcast its messages to those who are unable to attend the conventions. It was an arduous task to rebuild the mechanical associations, which were almost literally "shot to pieces" during the depression, but

they are making splendid comebacks. The Car Department Officers' Association hit on an excellent device for building membership last year. Each of the four vice-presidents were made general chairmen of the membership committees in their districts, and the membership has now been increased to over 1,400. The experiment has proved so successful that the officers are planning on redoubling their energies in this respect. This is quite necessary in order to justify and finance its excellent published proceedings. Friends and well wishers of the mechanical associations can well afford to get behind them in their membership drives.

Use of the "Mike"

Two of the associations, the Railway Fuel and Traveling Engineers and the Master Boiler Makers, insist that every speaker taking part in the discussions must come to the platform and use the "mike." It does take a little extra time, but that is much more than offset by the fact that everybody, even in the far corners of the hall, can follow the proceedings closely, and this immensely improves the quality of the meetings. Where no "mike" is available, and even if the meeting is small, those discussing the reports should be made to come to the platform and face the audience, even if only asking a question. Members soon become disinterested if they cannot hear clearly. A president of the Fuel and Traveling Engineers Association faced a real dilemma a few years ago in enforcing this rule about the "mike." His boss, who had a good voice, insisted on speaking from the floor. The presiding officer, however, would not allow this to be done and his boss was forced to come to the platform. For that particular meeting, at least, the president had no further difficulty in enforcing the rule. In one of the associations this year some very important announcements did not get over to the group as a whole, because the speaker did not use the "mike" and the presiding officer allowed him to get away with it.

Enroll in Your Profession

The art of successfully directing a body of men engaged in any phase of maintenance and repair work on locomotives and cars is such that the foremen and supervisors concerned should rightfully have the status of professional men. Added to the task of directing the energies of the human element—not an easy one—they must also be well grounded in an understanding of the best practices of getting the most from the tools and facilities. It is true that successful foremen and supervisors do have a good local standing, but many of them have no sense of professional consciousness and do little in cultivating contacts beyond their community, or division, or road. Membership in mechanical associations, such as those which met at Chicago, helps to supply these broader contacts and enables them to become identified as members of their profession. Such associations are made up of individual memberships on a voluntary basis and they thus include a body of men who are sincerely desirous of improving their knowledge and ability in the interest of better railroad operation.

Stimulate Discussion

It is sometimes a bit pathetic to watch a presiding officer try to get a discussion started. One association has been fairly successful in improving its practices in this respect, by seeing to it that at least one member is assigned the duty of opening each discussion—not to be called upon, but to secure recognition as soon as the discussion is called for. This "breaks the ice" and has been so effective that it would seem that it might be wise for the other associations to follow suit and appoint special committees, or at least take special measures to promote the practice. John Purcell, of the Santa Fe, has done wonders in the Mechanical Division by seeing that young men, and men of special ability, but not widely known, are sought out and encouraged to take part in discussions. Too much attention cannot be given to the appointment of technical committees; but there is also a large place for special committees or individual assignments for following up details of this sort which can do much to develop and draw out worthwhile information.

The Co-ordinated Exhibit

The railway supply exhibit was unusually complete and was well patronized. It justifies the part that the railway supply group has taken in assisting to revive the activities of the mechanical associations. Formerly when the conventions met at different times and places the exhibit problem was a serious one for the supply group, both as to expense and time required. And yet these exhibits are of great value, since they make it possible to do a fine piece of educational work among the foremen and supervisors who are concerned with the actual maintenance and operation of the equipment. In this respect the interests of the railway supply manufacturers and the railroad representatives are mutual. Because of it the railway supply representatives have recognized that the effectiveness of their exhibits depends upon the strength and virility of the railway associations. For that reason they have taken a keen and active interest in helping to develop the convention programs, where they could render special assistance. They have also used their influence to promote an increase in the membership of the four associations.

Why Not the "Poor" Roads, Too?

C. B. Hitch, superintendent motive power, Chesapeake & Ohio, in speaking extemporaneously before a meeting of the Locomotive Maintenance Officers' Association made the comment that he was fortunate enough to be working for a railroad that made a little money from its operations and that the management of that road was able to lay out its plans for equipment-repair programs several months in advance. This made it

possible to predict, with reasonable accuracy, the amount of repair work that would need to be done to maintain equipment in a satisfactory condition for the service expected. The most significant part of his remarks was to the effect that these plans made possible a rather stable operation throughout the year—in other words, stabilized employment [the interpretation is ours].

It was perfectly evident, in glancing over the audience, that there were two or three skeptics who would like to get up and say that it's easy to stabilize things and plan ahead when you've got plenty of money. Well, be that as it may, it's still a fact that the fellow who has money usually has it because he knows how to get it and how to spend it wisely after he gets it, and we have an idea that possibly one of the reasons why certain railroads are successful is because they are managed by men who are experts in spending money wisely; who are the kind of officers that know you can't do a good job when shop men have to work one month, then lay off for two or three. We couldn't help but think, as Mr. Hitch was telling about these things, that possibly the kind of management that makes the successful road successful would be pretty good management for some of the roads that aren't doing so well. So, where you find planned and stabilized operations, you will probably also find intelligent management and successful results.

A Step in the Right Direction

For three years the Locomotive Maintenance Officers' Association has been going through the trying period of making an old association over into a new one—one of specific functions, of broader scope in membership and one with a definite idea of its future place in the railroad industry. The registration at this year's meeting and the interest of the type of men who attended are a positive indication that the originally stated objectives of this group have met with the approval of mechanical officers all over the country and that the supervisors down on the firing line have reached the conclusion that here is an association which comes close enough to the real heart of the locomotive repair problem to be of real service to them. This must have been the case for they came and "joined up."

During this initial period the association's officers have built up interest by the presentation of papers and addresses by many men prominent in mechanical department work and now they realize that the time has come to do the real job they have had in mind all the time—the job of developing, by committee work, technical data on locomotive maintenance practices that will serve as an invaluable guide to that which is the last word in modern shop and enginehouse practice. So, in the years to come, if their work succeeds, the man in shop and enginehouse will have a source of information on those perplexing problems peculiar to our industry. The decision to establish permanent committees to develop technical reports is a real step forward and the association cannot fail in its efforts if the officers and supervisors on those roads not now represented among its members give it their support.

Steam's Future—A Warning?

These quotations are from reports of committees presented at this year's annual meeting of the Railway Fuel and Traveling Engineers' Association. Together, they sound a note which neither those interested in the future of the steam locomotive nor those identified with the bituminous coal industry can well afford to ignore.

* * *

"If coal is to meet the bitter competition of fuel oil, gas, and electricity produced by water power, the consumer must receive more heat value per dollar from coal than from other fuels and must know that he is getting it. If the steam locomotive is not to go the way of the covered wagon, it must operate as cheaply or more cheaply than other motive power."—From the report of the Committee on Coal Preparation.

* * *

"We cannot afford not to face the smoke nuisance. It is more than a nuisance—it is poison. The smoke peril will be poison to the bituminous coal industry, with a resultant loss in revenue to the majority of American railroads."—From the report of the Committee on Firing Practice—Coal.

* * *

"In passenger service the group of Diesel locomotives making the highest miles per month averaged 24,467 miles. The highest mileage group of steam locomotives averaged 17,363 miles per month. This group of Diesels—the best we have been able to find—made 41 per cent more mileage than the best group of steamers."—From the report on Locomotive Utilization.

Arbitrary Change In the Program

The Railway Fuel and Traveling Engineers' Association serves at least three groups with somewhat different major interests. This is reflected in the organization of the program of the annual meeting with a "Mechanical Day," an "Air-Brake Day," and a "Fuel Day." Such an arrangement is of service to those members who, because of their specialized interests, or because of pressing duties at home, find it inadvisable or impossible to spare time to attend the meeting from beginning to end. It may be a bit disturbing to these men to find that an appreciable part of the program for the day in which they are particularly interested has been drafted to fill out the programs of earlier sessions. Two of five items on this year's Fuel-Day program were thus used to extend the time of earlier sessions.

In preparing a convention program it is not easy to anticipate the exact amount of interest each subject will arouse and to appraise correctly the amount of time to allow for its discussion. With a large exhibit, ranging wide in its appeal, however, the two or two and one-half hours saved in attendance at the last session

would not have been wasted if, instead, they had been spent in the exhibit during earlier afternoons of the meeting, and those especially interested in the items advertised for Friday would have found no reason to feel "let down" after making special effort to be at that session.

The Car Men's Meeting

When 300 car men get together to discuss interchange rules or maintenance practices, something is bound to happen! Words flow! Differences of opinion are aired! And the presiding officer does mighty well if he can keep speakers on the subject. Next to fuel supervisors and boilermakers, car men are most loquacious when they get together, and the Chicago meeting proved that these men, who have an intimate working knowledge of car conditions, can take constructive action and make definite recommendations.

Association's Work Is Commended

From a small beginning, the Car Department Officers' Association has grown until it now has a membership of approximately 1,450. In the past three years particularly, its organization and method of functioning have been improved until it now promises to be a potentially important force for betterment in all matters pertaining to car-department operation. A real tribute to the work of the association is afforded by the fact that four railway executive officers and mechanical-department heads took the trouble to attend the Chicago meeting and make personal addresses.

The general tone of all of these addresses was congratulatory, with plenty of emphasis on things which the association and railway car departments in general can do to effect further economies in operation. The necessity of furnishing shippers with both standard and special-service cars was pointed out; also the desirability of supplying these cars in condition to carry loads to destination without delay or transfer due to equipment defects. The important objectives of greater car utilization, more car miles per day, increased speeds and higher car-mile earnings, all are vitally effected in some manner by the way in which car forces perform their daily work. A definite challenge was presented to the association by one mechanical-department head who said that the only way it can justify its existence will be by developing and putting into general use more efficient and dependable car-department methods and practices.

Supplements A. A. R. Mechanical Division

One point, specifically mentioned in the constitution of the Car Department Officers' Association and strongly emphasized in President Acworth's opening address, is that the association, composed of representative railroad and private car company officers and supervisors from all parts of the country, is intended to supplement and in no way duplicate or overlap the work of the parent A. A. R., Mechanical division, to which it submits constructive recommendations for formal approval before adoption as standard practice. How well the association functions for this purpose is demonstrated by the fact that last year's report of the C. D. O. A. Committee on Loading Rules was included practically without change in the report on the same subject presented to and adopted by the Mechanical Division at its Chicago meeting last June.

Similarly, some of the ground work for the Mechanical Division's action in making constructive revision of the A. A. R. Rules of Interchange is done by the Car Department Officers' committee on this subject. Standing committee reports on shop operations and tools, passenger-car terminal handling, inspection and preparation of cars for commodity loading, etc., all develop information and in due time recommendations having an important bearing on the car department objectives mentioned above. Certainly, if the Car Department Officers' Association fails to make a real contribution to these objectives, it will not be for the lack of opportunity.

Confusion in the Front Office

Many times during the meetings at Chicago a railroad officer would tell the assembled mechanical men that they should never forget their obligation to sell railroad service to the public and conduct their relations with the public in such a manner as to win friends for the railroads. With these words still fresh in our memory we went into the diner on our way home. Across the aisle were three men—not railroad men but cash customers—enjoying their morning oatmeal and coffee. In came the Pullman conductor and notified the travelers that certain cars were to be taken off the train at that terminal and put on another train. So, right in the middle of the oatmeal, the three men had to leave the diner.

We were conscious of a lot of switching and, when it was all over, back came the three men. After all the excitement somebody decided to put the cars back on our train. It is putting it mildly to say that these customers were slightly exasperated at having to eat breakfast in two sittings and were it not for the remarkably fine job of tactful explanation and apology on the part of the colored waiter, three good customers would have gone home fully convinced that next time they'd get their oatmeal on an airplane.

Here was a case where the train crew bore the brunt of a difficult situation because somebody "in the front office" couldn't make up his mind. Here is a clear cut example of public relations work—a railroad man should remember that any move he may make is liable to affect someone's travel comfort and his future attitude toward a railroad—traveling men don't like to have their breakfast interrupted.

High Spots in

Railway Affairs . . .

Railroad Employment

The last figures for railroad employment available when this column was written were for September. As has been true for some time, employment continued to increase, reaching 1,066,612. This was 0.68 per cent above the previous month, but 4.49 per cent over September, 1939. While all groups showed an increase compared to last year, the maintenance of equipment and stores group led with an increase of 7.37 per cent. The maintenance of way and structures group was up 5.99 per cent; yardmasters, switch tenders and hostlers 4.40 per cent, and train and engine service 3.87 per cent.

Transport Study Board

The Transportation Act of 1940 provided for a three-member board to make a study of the relative economy and fitness of the various agencies of transportation; the extent of government aids to each; and the extent to which taxes are imposed upon carriers. Apparently the board also has authority to review other phases of the transportation problem which it believes may require study and analysis. Although President Roosevelt signed the bill on September 18, no nominations for members of the board have as yet been sent to the Senate. The President did indicate at one of his press conferences that he doubted very much if any nominations will be sent up until the Senate returns with a quorum. The appointment of this board will therefore probably not be made until well after election.

Budd on Adequacy of Transportation

Ralph Budd, commissioner in charge of the Transportation Division of the National Defense Advisory Commission, in a radio broadcast early in October, discussed our transportation facilities in the light of national defense requirements. We are in a much better position than during the first World War. The railroads are supplemented by other types of transportation which have been developed since that time. Steps have also been taken to insure that the freight cars will not be used as warehouses, but will be unloaded promptly. While 20,000 miles of railroad line have been abandoned since the first World War, this was branch mileage which would not affect the present situation. While there are fewer cars and locomotives, those which were retired have been replaced by larger equipment, and in the case of the locomotives, much faster. Mr. Budd pointed out that since 1920 the railroads have spent over ten billions of dollars for improving tracks, signals and equipment, making for much higher speeds, greater safety and dependability. Except for unlooked for and unusual developments, therefore, transportation facilities are adequate for our national defense program.

Collective Bargaining

Judge Royal A. Stone, who acted as a referee for the National Railroad Adjustment Board, made a statement in his findings in a recent case that is worthy of careful and critical attention on the part of both men and management. He pointed out that collective bargaining, to be successful, must result in real contracts, binding on all parties, and must be enforced as written. "If either party," said Judge Stone, "can dictate the result by its economic powers (with threat of strike, lockout or layoff implied) or by threat to exercise that power rather than law and reason, what was intended to be a contract is converted into a mere deceptive bit of paper and collective bargaining thwarted of its essential purpose."

Grade Crossing and Trespassing Accidents

This year the Steam Railroad Section of the National Safety Council concentrated all its attention at its annual meeting on the problems involved in grade crossing and trespassing accidents. These cannot be reduced without co-operation from the public through education and law enforcement. Railroad men, in whatever department employed, can therefore well afford to lend their assistance and co-operation in awakening the public to its responsibility. The number of highway grade crossing accidents declined from 4.49 per million train-miles in 1930 to 4.12 in 1939. Considering the vast expenditures and great amount of effort that has been made to reduce such accidents, this improvement is not as great as was anticipated. The number of trespassers killed in 1939 was practically the same as ten years ago, no marked improvement being made in this respect. As Vice-President Gurley of the Santa Fe pointed out, a trespasser is one who has violated the rights of another and the public should establish adequate rules to prevent trespassing and enforce them by proper policing and discipline.

Steel Production Ample

Edward L. Ryerson, chairman of the board of the Inland Steel Company, in an address before the Association of Iron and Steel Engineers, indicated that he could see no reason why "war and rearmament demands upon the steel industry will be greatly in excess of our capacity to produce during the next year or two." He estimates that our national defense requirements and the demands of those countries that are looking to us for help in the production of war materials, will consume less than 20 per cent (19.3 per cent to be exact) of our total capacity. Said Mr. Ryerson, "No one can obtain comfort in the knowledge that any such amount of a highly developed and useful product is being made for the purpose of destruction, but we can find some satisfaction in the knowledge that the vast majority of steel products are still going into peaceful and useful services."

I. C. C. Weak Spot

The chairman of the Interstate Commerce Commission, Joseph B. Eastman, said in an address before the annual meeting of the Association of Interstate Commerce Commission Practitioners, that the weakest spot and one that has given the Commission much concern, was the long time which it has taken to decide many of its cases. "These delays," he said, "have not been caused by sloth or indifference." He gave as the chief causes of these delays: "(1) The sudden development within a short period, usually because of new legislation, of a great flood of cases, for the prompt handling of which our existing staff is inadequate. This happened after the passage of the Transportation Act, 1920, and also after the passage of the Motor Carrier Act, 1935. (2) The time required in obtaining the appropriation necessary to augment our staff for the handling of such accessions of work and in recruiting the new force under civil service regulations after the appropriation has been obtained. (3) Congestion of such cases after they have got by the staff and have reached a division of the Commission for decision. (4) The length of time required by public hearings in proceedings of great territorial scope in which a multitude of parties are interested. (5) The time sometimes taken by the Commission in reaching decisions and reframing reports, as a body of eleven men where sharply divergent views are developed." The Commission has struggled with these matters to the best of its ability and with some degree of success, and expects to find still other means of improvement.

Among the Clubs and Associations

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. — Fourteenth annual exposition Grand Central Palace, New York, December 2-7.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—Meeting November 21, 10 a. m., Ansley Hotel Roof Garden. Speaker: R. R. Royal, superintendent of shops, Illinois Central. Subject: Steam Locomotive Maintenance and Improvements to Existing Power.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS.—Meeting November 19 at 8 p. m., at the Hotel DeSoto, St. Louis, Mo. Speaker: V. R. Hawthorne, secretary, Mechanical Division, Association of American Railroads. Subject: Accomplishments and Responsibilities of Car Department Officers. Dinner in honor of Mr. Hawthorne at 6:30 p.m.

CANADIAN RAILWAY CLUB.—Meeting November 18 at 8:15 p. m. at the Windsor Hotel, Montreal. Speakers: Lem. Adams, vice-president, and F. C. Hasse, general manager, Oxweld Railroad Service Co. Subjects: (1) Unionmelt Welding—a new automatic welding process for locomotive and car construction; (2) The Butt Welding of Rails by the Pressure Method. Illustrated by films.

CHICAGO CAR FOREMEN'S ASSOCIATION.—At the annual meeting of the Car Foremen's Association of Chicago, held at the La Salle Hotel, Chicago, on October 4, the following officers were elected for the ensuing year: President, C. A. Erickson, general A.A.R. inspector, Chicago & North Western, Chicago; first vice-president, M. J. Mills, general car inspector, Pere Marquette, Grand Rapids, Mich.; second vice-president, H. B. Atherton, car foreman, Chicago Great Western, Chicago; treasurer, C. J. Nelson, superintendent, Chicago Car Interchange Bureau, Chicago; secretary, Geo. K. Oliver, assistant passenger car foreman, Baltimore & Ohio, Chicago Terminal, Chicago. ¶By virtue of his election to the presidency, Mr. Erickson becomes chairman of the board of directors. Other members of the board include: John Uhrig, master mechanic, Belt Railway of Chicago, Chicago; F. A. Shoulty, assistant superintendent car department, Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis.; F. L. Kartheiser, chief clerk-mechanical, Chicago, Burlington & Quincy, Chicago; William Hartnett, general car foreman, Chicago & North Western, Milwaukee, Wis.; J. S. Acworth, supervisor of equipment, General American Transportation Corporation, Chicago; C. W. Broo, general car foreman, New York, Chicago & St. Louis, Chicago; C. O. Young, chief clerk-mechanical, Illinois Central, Chicago; F. R. Callahan, superintendent of yards, Pullman Company, Chicago; R. R. Hawk, superintendent of car lines, Wilson Car Lines, Chicago; A. E. Smith, vice-president, Union Tank Car Company, Chicago; K. A. Milar, Milar & Company, Chicago; and W. J. Demmert, sales engineer, Griffin Wheel Company, Chicago.

* * *

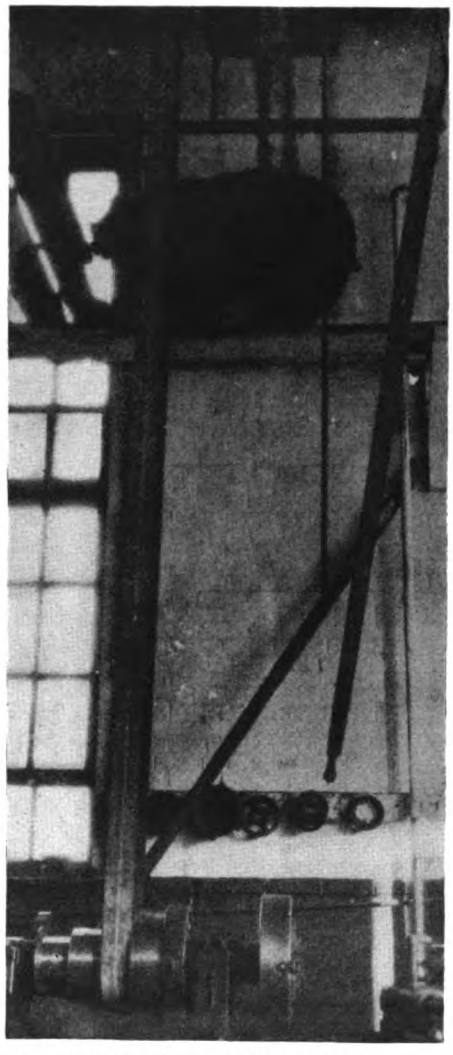


Photo by G. Morris Taylor, Jasper, Alta.

Bear in the Belfry

This photograph, taken by a member of the Canadian National Staff at Jasper, Alta., shows a fair-sized black bear discovered one morning on the shopping runway 16 ft. above the floor of the machine shop of the Jasper enginehouse where he had gone to get warm during the night. Since Jasper is located in a national park and game sanctuary the presence of such animals in the nearby countryside is not unusual, but this is the first Bruin to have made a roundhouse the scene of his meditations.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The sixty-first annual meeting of The American Society of Mechanical Engineers will be held in New York, December 2-6. The meeting headquarters will be at the Hotel Astor instead of at the Engineering Societies building. More than 100 technical papers will be presented on such specialized mechanical engineering subjects as aeronautics, applied mechanics, fuels, machine-shop practice, railroads, etc. Warren H. McBryde, president of the society, and a member of the National Defense Commission will be the speakers at the banquet on Wednesday evening, December 4. President McBryde will also present to outstanding American engineers the 1940 awards of the society, including the A. S. M. E. Medal, Holley Medal, Worcester Reed Warner Medal, Melville Medal, etc., the Charles T. Main award of $150, and two Student Awards of $25 each. For the two railroad sessions the following tentative program has been prepared:

THURSDAY MORNING, DECEMBER 5

Railroad I

Report of Committee on Survey, RR-6, 1940, by Prof. E. G. Young, University of Illinois

Graphical Methods for Plotting Time, Speed, Distance Curves for Railway Trains, by A. I. Lipetz, chief consulting engineer in charge of research, American Locomotive Company

A Fundamental Development in Suspension and Construction for Railroad Cars, by Paul K. Beemer, E. F. Stoner, W. E. VanDorn, Pacific Railway Equipment Company, and F. G. Lindvall, California Institute of Technology

THURSDAY AFTERNOON, DECEMBER 5

Railroad II

Modern Objectives in Steam Locomotive Design, by R. M. Ostermann, vice-president, Superheater Company

Acceleration—Steam Locomotives, by L. B. Jones, engineer of tests, Pennsylvania Railroad

The officers to be installed for the year 1941 are: President—William A. Hanley, director of Eli Lilly & Co., Indianapolis, Ind.; vice-presidents—Samuel B. Earle, research engineer and dean of engineering, Clemson Agricultural and Mechanical College, Clemson, S. C.; Frank H. Prouty, a partner in the Prouty Brothers Engineering Company and the Industrial Appraisal Company, both located in Denver, Colo., and Edwin B. Ricketts, mechanical engineer, Consolidated Edison Company of New York, New York. Managers—Huber O. Croft, professor of and head of the department of mechanical engineering, University of Iowa, Iowa City, Iowa; Paul B. Eaton, consulting engineer, and professor and head of mechanical-engineering department, Lafayette College, Easton, Pa., and George E. Hulse, chief engineer, The Safety Car Heating and Lighting Company, New Haven, Conn.

(*Turn to next left-hand page*)



The unique exchange plan, possible only because a scrap wheel is the best basic raw material for a new wheel, has made, and will continue to make chilled car wheels more economical to buy, just as their unusual characteristics make them more economical to operate.

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NEWS

B. & O. Has Five Diesel-Driven Trains in Service

THE Baltimore & Ohio has recently placed in service seven new 2,000-hp. Diesel-electric locomotives; five of its through trains—the Capitol Limited and the Shenandoah between Washington, D. C., and Chicago, the National Limited between Washington and St. Louis, Mo., the Royal Blue and the Columbian between Washington and New York and the Abraham Lincoln of the Alton between Chicago and St. Louis—are now operated entirely by Diesel electric power.

Williamson and Shriver Receive Goodrich Awards

DECLARING that the American railroads are better prepared to meet the defense needs of the country than any other single unit of the national economy, President Frederick E. Williamson of the New York Central, pictured defense traffic needs at the Goodrich Arena at the New York World's Fair on October 1, after receiving the B. F. Goodrich Company's award for distinguished public service. In presenting the award, David M. Goodrich, chairman of the rubber company's board, told Mr. Williamson that it was made "in recognition of your service to our country in the important field of transportation; of your helpful association with the United States Railroad Administration during the World War; of your executive interest in the Association of American Railroads, and of your leadership in the transportation industry."

The New York Central president estimated that the carriers would be called on to provide 25,000 cars per week for preparedness purposes, which would mean a rail movement of approximately 4 per cent of the average weekly loadings in 1939.

George M. Shriver, senior vice-president, Baltimore & Ohio, in accepting the B. F. Goodrich award for distinguished public service at the Goodrich arena declared that the railroads as a whole are aware of existing and future traffic demands and have taken every means to put properties and equipment in shape. In noting the use of rubber in railroad equipment, Mr. Shriver pointed out that the B. & O. has been prompt in utilizing rubber in improving car construction, devising such methods of applying the material as to avoid the vibration of metal on metal.

Car Service Division Sees Need for Purchase of 100,000 Cars

While official confirmation has been unobtainable at the offices of the Association of American Railroads, it has been learned that the Car Service Division has recently completed a survey of the equipment situation, reaching the conclusion that the railroads should purchase approximately 100,000 new freight cars by October 1, 1941.

According to the report, the conclusion of the Car Service Division is that the industry as a whole should have by October 1, 1941, a total of 1,680,000 cars, of which 94 per cent or 1,579,200 should be in good order. After making allowances for prospective retirements and other factors the study came up with the aforementioned conclusion that the buying programs of the next 12 months should contemplate the purchase of 100,000 cars. Moreover, the study surveyed the equipment needs of each road, and broke down the 100,000 total by roads and by types of equipment.

It is understood that most of the roads have indicated a disposition to pursue equipment-acquisition programs which will be in line with the Car Service Division's conclusions; but there has been some reluctance to go along on the part of a few roads, particularly in Western territory, where there has as yet been no substantial pick-up in traffic due to the national defense program. Meanwhile, however, there have been suggestions to the effect that the railroads should get their equipment orders placed before the car builders are booked to capacity as a result of other business coming to them in connection with the defense program.

Roads Have Passed Three Tests Says Pelley

FOR the third time since May, 1939, the railroads have successfully met the test of readiness and capacity precipitated by unusual season and defense traffic, according to J. J. Pelley, president of the Association of American Railroads, before the Transportation Luncheon of the Illinois Chamber of Commerce at Chicago on October 10. "In May, 1939," Mr. Pelley said, "the railroads of the United States were asked about their readiness. We reported then that the railroads had ample line-haul capacity between terminals; that they had ample terminal capacity, provided that freight be unloaded promptly upon arrival; that with this capacity on the line and in terminals, they could handle 25 per cent more business than was moving at that time; and that upon the completion of an extensive program of repairing equipment they could handle 45 per cent more.

"The first test of that estimate of what the railroads could do came in September and October of 1939. The usual fall increase in business, plus the buying rush that started with the outbreak of war in Europe, caused the sharpest, fastest rise in freight traffic ever recorded. At the peak of that rise, in October, 1939, although the program of equipment repair was then far from complete, the railroads were handling not 25 per cent more business than in May, and not 45 per cent more, but actually 55 per cent more. And they were doing it without congestion, delay or car shortage.

"Again, this year the railroads met another test of their readiness and capacity. During the recent maneuvers in August, in close co-operation with the army, 150,000 men were handled in three days at an average of 50,000 per day, an increase of 13,000, or 35 per cent, over the average daily movement of troops in July, 1918, the peak month of the World War troop movement.

"And right now in this autumn of 1940 the railroads are once again proving that they can handle the demand for transportation. . . .

"The railroads are ready because, ever since the last war, they have been improving their plant, bettering their organization, and increasing their efficiency.

"They have 628,000 fewer cars than they had in the war year of 1918, it is true; but today's cars average nearly 20 per cent bigger than those of 1918, and are so much better in other ways ways that it is hard to compare them. The railroads have 22,000 fewer locomotives than they had then, but today's locomotives have nearly half again as much pulling power, and have gained even more in efficiency in moving heavier loads at higher speeds.

"These cars and locomotives run on better tracks and through better terminals. How much better plant and equipment are than they were in 1918 is indicated by the fact that today's freight trains are nearly two-thirds faster, on the average, than those of 1918, and that they turn out more than twice as much transportation service per hour, on the average, than they did then.

"Just in the past twelve months . . . here is what the railroads have done to keep themselves ready to meet the demands of commerce. Between September 1, 1939, and September 1, 1940, they reduced the ratio of bad-order freight cars from 13.8 per cent to 8.6 per cent. In the same twelve months they placed in service 54,615 new freight cars. The combined result was an increase in the supply of serviceable cars from 1,425,820 on September 1, 1939, to 1,503,055 on September 1, 1940, and the supply of serviceable freight cars continues to increase."

Pullman Denies Monopoly Charge

AN article denying charges by the department of justice that the Pullman Company, its subsidiaries and its officers have violated the Clayton and Sherman acts was filed by the defendants with the district court at Philadelphia, Pa., on October 15. As reported in the August *Railway Mechanical Engineer*, Page 333, the department filed a civil suit on July 12

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To Increase the Load . . .

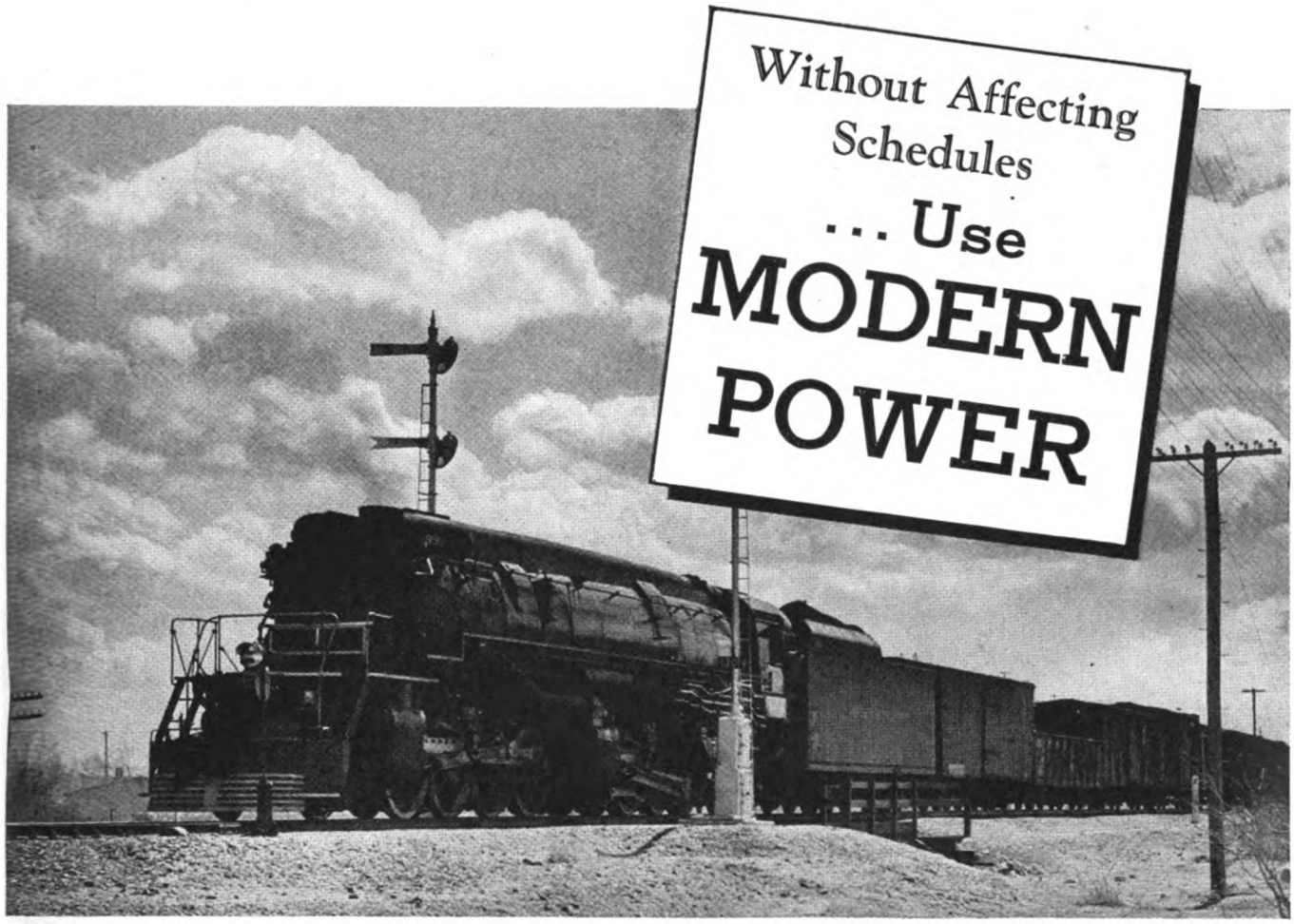


Photo courtesy Southern Pacific Company

Only *Modern Power* is capable of increasing the load without affecting schedules. Today, when all industry is being called upon to speed-up production and delivery, progressive railroads are solving their increased load problem . . . . . economically and effectively . . . . . with Modern Power.

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charging, in brief, that the Pullman organization has prevented the railroads from using modern lightweight, streamline cars manufactured by competing companies and from operating their own sleeping cars and has forced the railroads to purchase cars from Pullman's manufacturing subsidiary.

The defendant's answer contends that the Pullman Company was organized to establish an economical system for providing sleeping-car service, and denies that it has ever pursued any policy of refusing to improve its sleeping cars or of refusing to keep such equipment up to the standards of safety, speed, comfort or convenience made possible by advancements in rolling-stock construction, or that the Pullman Company has consistently refused to adopt improvements in quality, design, material or safety made available to it which would make the cars better in respect of safety, earning power or riding comfort. The fleet of Pullman pool cars has been modernized by placing in operation 383 new type lightweight sleeping cars constituting 5.63 per cent of the total number of cars in the Pullman pool; and with inclusion of such cars already purchased for early delivery the percentage of such replacements is 6.7 per cent. The railroad-owned lightweight cars, including those on order, aggregate 1,333 units or 3.7 per cent of the 35,722 passenger train cars owned by class 1 railroads as of July 1, 1940."

They deny "that the entire program or any part thereof of modernizing passenger transportation by the use of high-speed trains has been thwarted, restrained or stifled by them. Standard and the Pullman Company have been foremost in developing, building and furnishing lightweight cars and trains and the railroads, in adopting such equipment as a means for improving their passenger traffic, have received the active co-operation of these companies in research, in solving engineering problems and in other phases of this development. Standard has endeavored to promote its business by sales of lightweight equipment. The Pullman Company has offered to furnish and has furnished contracting railroads with lightweight sleeping cars. The answer also comments upon the use of various metals, including aluminum alloy, used in the construction of lightweight trains and pointed out that "this material was used by standard in the construction of the City of Salina train for the Union Pacific which was the first successfully operable lightweight streamline train built and delivered to a railroad in the United States. Subsequently numerous other trains were constructed of the same material by Standard and by other car builders."

Equipment Depreciation Orders

EQUIPMENT depreciation rates for sixteen railroads, including the Akron, Canton & Youngstown, the Florida East Coast, the Green Bay & Western and the Pittsburgh & Western Virginia have recently been prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in

(*Continued on second left-hand page*)

Orders and Inquiries for New Equipment Placed Since the Closing of the October Issue

LOCOMOTIVE ORDERS

Road	No. of Locos.	Type of Locos.	Builder
Chesapeake & Ohio	10	2-6-6-6	Lima Loco. Wks.
Illinois Central	1	2,000-hp. Diesel-elec.	Electro-Motive Corp.
	2	2,700-hp. Diesel-elec.	
Southern	1	1,000-hp. Diesel-elec.	Electro-Motive Corp.
	5	1,000-hp. Diesel-elec.	
	3	600-hp. Diesel-elec.	
Wheeling & Lake Erie	2	600-hp. Diesel-elec.	American Loco. Co.
	7	.....	American Loco. Co.

FREIGHT-CAR ORDERS

Road	No. of Cars	Type of Cars	Builder
Atlantic Coast Line	128[1]	Auto-box	Pull.-Std. Car Mfg. Co.
Baltimore & Ohio	750	70-ton gondolas	American Car & Fdry. Co.
	1,000	50-ton wagon-top box	Company shops
	750	70-ton gondolas	American Car & Fdry. Co.
	250	65-ton gondolas	Bethlehem Steel Co.
Chicago & Eastern Illinois	200	50-ton rebuilt hopper	(See Note 2)
C. B. & Q.	1,000	Box	Company shops
Chicago, Indianapolis & Louisville	20	50-ton ballast	American Car & Fdry. Co.
Duluth, Missabe & Iron Range	30	Ballast	American Car & Fdry. Co.
	10	Hoppers	
Great Northern	1,000	Box	Pull.-Std. Car Mfg. Co.
	500	Box	American Car & Fdry. Co.
	500	Box	Pressed Steel Car Co.
Lehigh Valley	500	55-ton box	Pressed Steel Car Co.
	250	Gondolas	Bethlehem Steel Co.
Louisville & Nashville	500	50-ton hoppers	Pull.-Std. Car Mfg. Co.
M., St. P. & S. Ste. M.	400	Box	Pull.-Std. Car Mfg. Co.
	100	Automobile	
Norfolk & Western	500	55-ton gondolas	Virginia Bridge Co.
	500	55-ton gondolas	Ralston Steel Car Co.
National Carbide Corp.	12	Flat container	American Car & Fdry. Co.
New York Central	1,000[2]	70-ton gondolas	Despatch Shops, Inc.
Panama R. R.	20[4]	Flat	Magor Car Corp.
	30[4]	Box	
Pere Marquette	200	50-ton box	American Car & Fdry. Co.
	150	50-ton box	Gen. Amer. Transp. Corp.
	150	50-ton box	Pull.-Std. Car Mfg. Co.
	100	50-ton auto-furniture	Greenville Steel Car Co.
	200	L.S. 70-ton gondolas	Bethlehem Steel Co.
Reading	1,000[5]	50-ton hopper	Company shops
	50	Caboose	
Seaboard Air Line	50[6]	70-ton hoppers	Pull.-Std. Car Mfg. Co.
Southern	1,500[7]	40-ton box	Pull.-Std. Car Mfg. Co.
	750	50-ton hopper	Pressed Steel Car Co.
	730	H.S. 50-ton gondolas	American Car & Fdry. Co.
	250	L.S. 50-ton gondolas	Mt. Vernon Car Mfg. Co.
Tennessee Central	65	Hoppers	Pull.-Std. Car Mfg. Co.
Union Pacific	1,000	50-ton ballast	American Car & Fdry. Co.
Wheeling & Lake Erie	302	50-ton box	Pull.-Std. Car Mfg. Co.
	200	50-ton box	American Car & Fdry. Co.

FREIGHT-CAR INQUIRIES

Road	No. of Cars	Type of Cars	Builder
A. T. & S. F.	500, 1,000 or 2,000	Box	.....
	200	50- or 70-ton gondolas	
	200	50- or 70-ton hoppers	
	25 or 50	70-ton gondolas	.....
	50	70-ton flat	.....
Detroit, Toledo & Ironton	300	50-ton gondola	.....
Erie	500[8]	50-ton hopper	.....
	300	50-ton box	.....
	250	70-ton gondolas	.....
	100	50-ton furniture	.....
	50	70-ton flat	.....
Lehigh & New England	300	50-ton hopper	.....
Southern Pacific	500-2,000	Box	.....
Pacific Fruit Express Co.	1,000	Refrigerator	.....
St. Louis & Southwestern	50	70-ton rack	.....
	50	70-ton gondola	.....
	100	50-ton box	.....
	200	50-ton box	.....
Union Pacific	2,000	Box	.....

PASSENGER-CAR ORDERS

Road	No. of Cars	Type of Cars	Builder
Illinois Central	2	Rail-motor	American Car & Fdry. Co.
	1	Two-unit rail car	
Southern	6	Pass.-bagg.	[9] Pull.-Std. Car Mfg. Co.
	6	Partition coaches	
	18	Coaches	
	5	Diners	
	3	Obs.-lounge-taproom with round ends	
	3	Obs.-lounge-taproom with square ends	
	2	Mail-bagg. with 6-ft. mail section	
	2	Mail storage	
	2	Mail-bagg. with 30-ft. mail section	

[1] In addition to 600 auto-box cars reported in the October issue. The order for 125 flat cars also reported in the October issue has been cancelled.
[2] Purchased from a broker; formerly owned by Public Service Co. of N. J.
[3] For service on Pittsburgh & Lake Erie.
[4] Total cost, $209,460.
[5] Construction authorized by directors.
[6] Delivery received.
[7] Subject to I. C. C. approval of financing.
[8] In addition to 325, 70-ton mill-type gondolas being built in company shops at Dunmore, Pa., as reported in the October issue.
[9] For use in three seven-car and three eight- and nine-car trains scheduled for service early in 1941 between New York and New Orleans, La., and between Washington, D. C., and Memphis, Tenn.

over 7 million miles

(IN THE FIRST SIX YEARS)

OF SUCCESSFUL OPERATION PROVE SECURITY CIRCULATORS GIVE BETTER COMBUSTION FOR YOUR LOCOMOTIVES

THE demand for greater boiler horsepower brought about the larger firebox, which in turn presented a problem in arch brick support. To meet this condition The American Arch Company, in its continuous study for the improvement of combustion, developed the Security Circulator. While the original object of improved support was achieved, many other benefits have accrued.

Notable among these is the reduced cost of maintaining the arch as compared with other forms of arch brick support. Boiler maintenance is also lessened due to the reduction of honeycombing and cinder cutting. As for the Security Circulator itself, experience has shown a gratifyingly low maintenance cost.

The 564 Security Circulators, that have been installed on 115 locomotives during the last six years, have attained a record of over 7,000,000 engine miles of service, in which their performance has been thoroughly proved.

COMPANY, INC.

NEW YORK CHICAGO

No. 15100, Depreciation Charges of Steam Railroad Companies. The composite percentages for all equipment, which are not prescribed rates, range from 2.56 per cent for the Rockingham to 9.17 per cent for the Smoky Mountain.

The A. C. & Y.'s composite percentage is 4.55, derived from prescribed rates as follows: Steam locomotives, 3.55 per cent; freight-train cars—owned, 8.01 per cent, leased, 3.68 per cent; passenger-train cars, owned and leased, 3.83 per cent; work equipment, 3.61 per cent; miscellaneous equipment, 17.96 per cent. The F. E. C.'s composite percentage (3.48) is derived from prescribed rates as follows: Steam locomotives, 3.39 per cent; other locomotives, 6.61 per cent; freight-train cars, 3.4 per cent; passenger-train cars, 3.19 per cent; work equipment 5 per cent; miscellaneous equipment 18 per cent. The Green Bay & Western's composite percentage (3.77) is derived from prescribed rates as follows: Steam locomotives, 3.85 per cent; freight-train cars, 3.54 per cent; passenger-train cars, 3.39 per cent; work equipment, 7.81 per cent; miscellaneous equipment, 15.65 per cent. The P. & W. V.'s composite percentage is 3.29, derived from prescribed rates as follows: Steam locomotives, 3.29 per cent; freight-train cars, 3.27 per cent; work equipment, 3.73 per cent; miscellaneous equipment, 17.75 per cent.

Steel Industry Ready to Grow

A BRIGHT future for industrial progress was painted by Irving S. Olds, newly elected chairman of the board of the United States Steel Corporation at a luncheon in Chicago on September 19, while he and members of the board were making a tour of subsidiary plants. The luncheon given by Benjamin Fairless, president, was attended by several hundred business representatives of Chicago. Mr. Olds said in part:

During the hearings before the Temporary National Economic Committee less than a year ago the thesis was advanced that industrial progress in the United States has reached its zenith—that no frontiers are left for business to conquer—that as a consequence our earlier economic notions about business must be completely revamped. I am not a believer in any such defeatist arguments. Unless we are to have a complete departure from the system of private enterprise which developed this country and made it the envy of the industrial world, I am confident that American business, if given a fair chance, will continue to develop and to go forward; that American resource and ingenuity will produce new inventions and new processes, opening up new lines of industrial activity; that private capital will be required and will be available for the financing of these new enterprises, as well as for taking care of the normal growth and development of established industries.

"The steel industry has not stood still in the past. I do not anticipate that it will do so in the future. As many of you know, the methods used in the production of certain flat rolled products, notably tin plate, sheets and strip, have been almost completely revolutionized during the past ten or twelve years. This period witnessed the investment by the steel industry of many hundreds of millions of dollars in new facilities to produce these new products. The capital expenditures of the United States Steel Corporation during the last ten years have aggregated more than $500,000,000. The result of all this to the consuming public has been greatly superior products at lower prices. New uses have been made of these new products. This in turn has led to the establishment of new industries and new fields of employment, both for capital and for men. This is real industrial progress, which can and should go on indefinitely.

"Not so many months ago the charge was made that the steel industry is burdened with excessive steel-making capacity. These critics confused excess capacity with idle capacity. They merely compared ingot production for a year, or the average for a period of years, with the higher ingot capacity figures for the same period . . . Everyone knows that steel, for the most part, is a basic material used in the further manufacture of some finished product and that the demand for steel is entirely dependent upon general business conditions. This results in those peaks and valleys which are so characteristic of the business cycle.

"The proper function of the steel industry requires that it should be equipped and ready to furnish steel of a constantly improving quality when and as needed by the consuming public. It met these peak demands in 1929, again in 1937, and last week [the week ended September 14] the industry operated at about 92 per cent of ingot capacity . . .

"Where would we be today in our ability to carry forward the national defense program, if the steel industry had adopted the philosophy of these critics and had scrapped as 'excess' those parts of its steel making and finishing facilities which were idle in the depression years, or as recently as 1936 or 1938? Before the present emergency is over, it is conceivable that the steel-making capacity of the country may be pushed to the very limit to take care of the total demand, unless priorities of some kind are established giving preference to certain lines of activity."

Equipment Purchasing and Modernization Programs

The Canadian National has awarded a contract to the Piggott Construction Company, Saskatoon, Sask., for the addition of six stalls, each 110 ft. long, to the the enginehouse at Nutana, Sask. The walls will be of solid brick construction with timber posts and roof beams. Doors of steel frame construction will be hung on steel door posts. The roof will consist of 2 in. by 3 in. laminated fir with a five-ply asphalt saturated felt and gravel covering.

The Chicago, Burlington & Quincy is constructing a 135-ft. turntable at Clyde, Ill., to replace an existing turntable 100 ft. long. The work is being done by company forces and will cost approximately $45,000.

The Chicago, Rock Island & Pacific has asked the Interstate Commerce Commission for authority to assume liability for $2,758,000 of two per cent equipment-trust certificates, maturing in 14 equal semi-annual installments ending November 1, 1947. The proceeds of the certificates will be used to refinance conditional sales contracts now in force for 261 units of equipment costing a total of $4,420,075, all of which has either been received from the builders or contracted for. The petition states that the refinancing will result in a considerable saving to the company.

A contract has been awarded the Priester Construction Company, Rock Island, Ill., for a one-story brick addition, 50 ft. by 90 ft., to the enginehouse at Silvis, Ill. The total cost of the work will be approximately $25,000.

The Illinois Central.—The Interstate Commerce Commission has approved a plan whereby the road will sell to the Reconstruction Finance Corporation $11,016,000 of three per cent equipment trust certificates, maturing in 24 equal semi-annual installments of $459,000. The proceeds will constitute the bulk of the purchase price of equipment costing a total of $11,094,362 and consisting of 3,000 steel box cars, and one streamline train composed of the following units: one 2,000-hp. Diesel-electric locomotive, one baggage dormitory car, one lounge-observation car, one dining and kitchen car, four straight coaches, two single rail motor cars, one two-car rail motor unit, and four 2,000-hp. Diesel-electric locomotives.

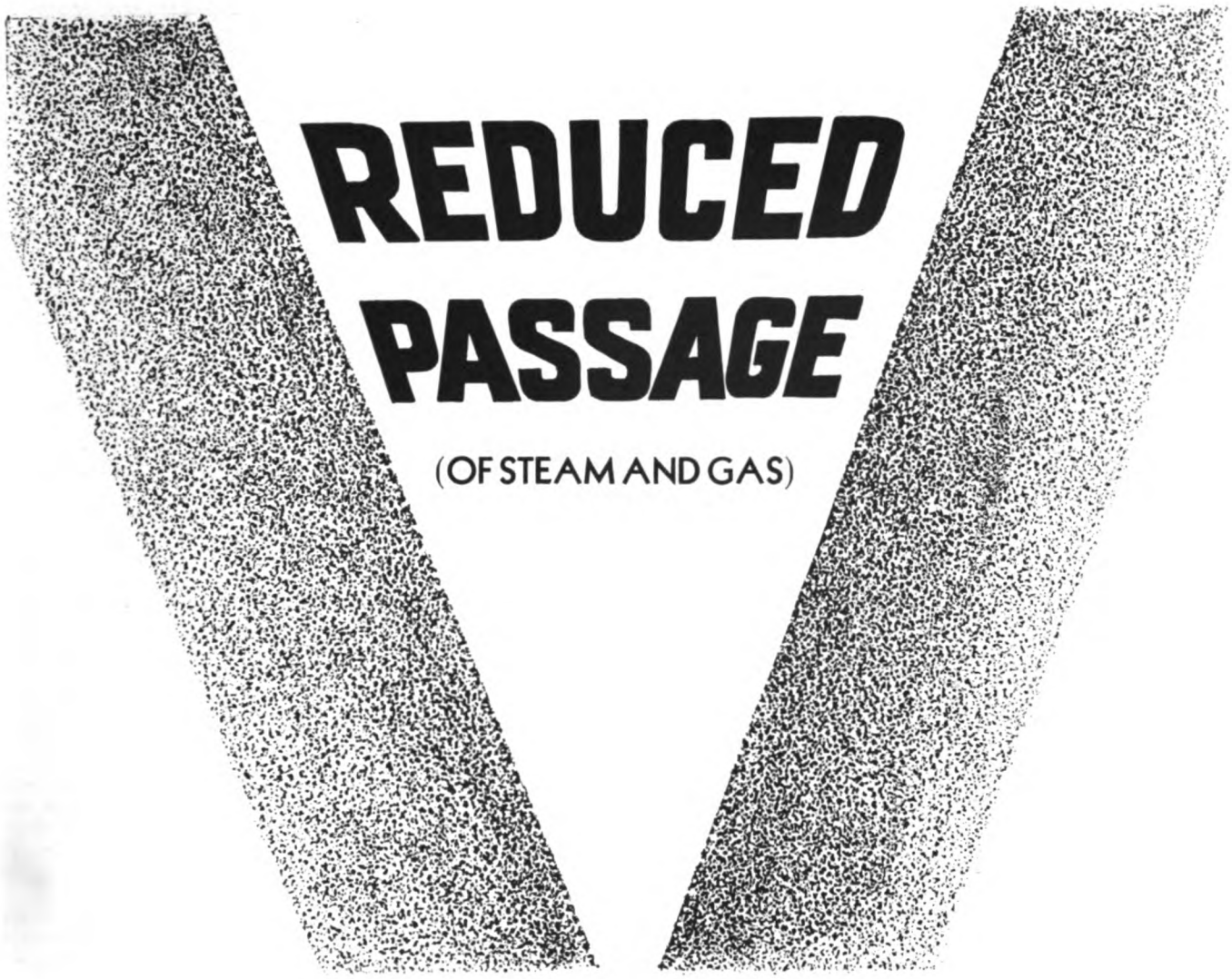
The New York, New Haven & Hartford has awarded a contract to the Ross and White Company, Chicago, for the furnishing and erection of complete sand-handling equipment for sanding locomotives on four tracks, which will be installed at Midway, Conn.

The Norfolk & Western will spend $4,700,000 for additions and betterments to its yards at Roanoke, Va. Work on the project will begin immediately and is expected to require about two years for completion. Minor items included in the expenditures are supplementary engine terminal facilities, such as, ash hoists, engine washing platforms, engine inspection pits, and pneumatic tube system for transmitting reports from inbound engines to the enginehouse office.

Northern Pacific—The directors of the Northern Pacific have authorized the purchase of 14 steam locomotives, and six Diesel-electric switching locomotives.

The Southern has asked the Interstate Commerce Commission for authority to assume liability for $7,300,000 of 1⅞ per cent equipment trust certificates, maturing in 10 equal annual installments of $730,000 each on November 1, in each of the years from November 1, 1941, to November 1, 1950. The proceeds will be used as a part payment for equipment costing a total of $8,147,000 and consisting of 1,500 box cars, 750 hopper coal cars, 1,071 gondola cars, and eight Diesel-electric switch engines. The petition states that the new freight cars will, at a conservative estimate, reduce the company's annual hire of equipment charge by $825,000. The issue has been sold to Drexel & Co. and Laurence M. Marks & Co. at 100.568, making the aver-

(Continued on next left-hand page)



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The efficiency of the superheater depends upon maintaining the original diameters of the steam and gas passages. When the return bend section of a *repaired* superheater unit is butt-welded to the tubing, the original diameters of the tube are lost because of the added metal.

When Elesco REmanufactures your superheater units, it is not a patched job. The return bend is machine-die-forged to the usable tubing and the result is a homogeneous structure . . . with the same inside diameter as the original unit.

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AMERICAN THROTTLES • STEAM DRYERS
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age annual cost to the company approximately 1.77 per cent.

The Union Pacific has started work on the construction of a 120-ft. turntable at Cheyenne, Wyo., which will replace a 100-ft. turntable. The work is being done with company forces and will cost approximately $56,000.

The Wheeling & Lake Erie has asked the Interstate Commerce Commission for authority to assume liability for $1,550,000 of serial equipment trust certificates, maturing in equal annual installments on November 15 of each of the years from 1941 to 1950, inclusive. The proceeds will be used as part payment of the purchase price of equipment costing a total of $2,242,466 and consisting of seven 2-8-4 freight locomotives and 500 all-steel 50-ton box cars.

Shipper Aid Sought in Car Situation

BECAUSE of the "excellent results" obtained through a similar communication issued last Fall, W. C. Kendall, chairman of the Car Service Division, Association of American Railroads, on September 26 sent to all members of the Shippers Advisory Board a letter outlining the car situation and calling upon shippers and receivers of freight to cooperate in various ways "to the end that maximum utilization of the available car supply may be obtained." At the same time Mr. Kendall sent to all railroads a circular calling attention to the shipper letter and suggesting that "if car requirements this Fall are to be satisfactorily met, roads must 'brush out the corners' to, in every possible way, prevent lost of car days, and increase car efficiency."

Among other things, the letter tells the shippers that there have been installed "in the last year" 66,838 cars built new, in addition to rebuilt and repaired cars; and as of September 1, the net increase in serviceable cars, compared with September 1, 1939, was 77,235, including 20,607 box cars and 59,163 gondolas and hoppers. Moreover, 18,458 new cars were on order as of September 1. "It is believed," Mr. Kendall added, "that we cannot do better than to ask renewed adherence" by shippers to the recommendations originally incorporated in last Fall's letter. One of these recommendations is "that shippers relax somewhat the more technical requirements as to car condition, and cooperate to the fullest possible measure by utilizing without rejection cars furnished by the railroad, if such cars have been approved by the railroad mechanical inspector for the commodity to be loaded."

In the circular issued to all railroads, Mr. Kendall calls attention to the Shippers Advisory Board's estimate of an increase of seven per cent in car loadings for the fourth quarter of 1940, as compared with the corresponding quarter last year. He added: "Whether or not these expectations are realized (and the Board forecasts have proven remarkably accurate as to loading trends in the past, railroads may expect a considerable strain upon car supply during the coming Fall months, despite the net increase of 77,235 serviceable cars as of September 1, 1940, compared with September 1, 1939."

Benefit Payments to Jobless Railroad Men Increased

INCREASES in benefits for unemployed railroad workers went into effect November 1 under the amendments to the Railroad Unemployment Insurance Act recently adopted by Congress and approved by the President on October 10, according to an announcement from the Railroad Retirement Board which administers the Act. Benefit payments thereby have been increased on the average by some 75 per cent.

Under the amended law an eligible unemployed railroad worker will be paid for every day of unemployment in excess of four in a period of 14 consecutive days, whereas under the original act he could receive benefits only for every day of unemployment in excess of seven in a period of 15 consecutive days. This means that a worker with five to seven days of unemployment who would have received nothing before the act was amended will now be paid from one to three days' benefits, and that a worker with eight or more days of unemployment in a period of two weeks will now get benefits for three more days than he could have received before.

The amount of daily benefits is increased by the amendments from $2.50 to $3.00 for workers with annual wages of $1,000 to $1,024, from $2.75 to $3.00 for workers with annual wages of $1,025 to $1,299, from $3.00 to $3.50 for workers with annual wages from $1,300 to $1,599, and from $3.00 to $4.00 for workers with annual wages of $1,600 or more. No change from the existing act is made in the daily benefit rate to be paid workers who earned between $150 and $1,000 in a preceding calendar year.

The number of days for which a worker may draw benefits is increased from 80 days to a maximum of 100 days a year. The maximum amounts of benefits per year, which originally ranged from $140 to $240, depending on the earnings in a preceding calendar year, will now vary between $175 and $400.

The benefit year in the course of which an unemployed worker may receive a maximum of 100 daily benefits is now defined as the 12-month period from July of one year through June of the following year. The daily benefit paid in the benefit year is determined by the amount of wages earned in the base year, which is the calendar year preceding the beginning of the benefit year.

"The important increase in the benefit rights of unemployed railroad workers is made without increasing the contributions from employers which maintain the system," concludes the Board's statement. "It is estimated that the present contribution rate of three per cent of the payroll, exclusive of the excess over $300 in monthly earnings per employee, will be sufficient to support the higher level of benefits."

Supply Trade Notes

THE GLOBE STEEL TUBES COMPANY has established a sales office at 1033 Broad Street Station Building, Philadelphia, Pa., in charge of Paul C. Lewis, sales agent.

◆

E. L. ETTENGER has been appointed district representative of the Union Railway Equipment Company, with headquarters at Washington, D. C.

◆

A. TAURMAN, with headquarters at 848 South 42nd street, Birmingham, Ala., has joined the O. M. Edwards Co. of Syracuse, N. Y. Mr. Taurman's career includes a number of years' employment with the Southern as an apprentice, machinist, foreman, draftsman, and shop engineer, successively; resident inspector with the American Locomotive Company at Richmond, Va., and with the New York Air Brake Co., at Watertown, N. Y.

◆

NEW YORK AIR BRAKE COMPANY.—Three separate but related branches of engineering have been established by the New York Air Brake Company, Watertown, N. Y.—Development, Mechanical, and General. The respective departments are in charge of *H. N. Sudduth,* engineer of development and tests; *H. F. Halladay,* mechanical engineer, and *A. W. Laird,* general engineer.

◆

H. J. BARTON has been appointed to the Tool Steel division in the Southern California territory of the Allegheny Ludlum Steel Corporation.

THE CARBOLOY COMPANY, INC., is opening a branch office at 5905 Pacific boulevard, Huntington Park, Los Angeles, Calif. The offices will be in charge of J. W. Doody and Ray D. Mack.

◆

IRVING H. JONES, formerly manager of railroad sales of the Timken Steel & Tube Company, has been appointed manager of railroad sales of the Allegheny Ludlum Steel Corporation, Pittsburgh, Pa.

◆

GISHOLT MACHINE COMPANY.—George H. Johnson has been elected president of the Gisholt Machine Company, Madison, Wis., succeeding his father, Hobart S. Johnson, who has been elected chairman of the board. H. S. Johnson, Jr., has been elected vice-president.

HAROLD B. THOMAS, one of the founders of the Elastic Stop Nut Corporation, Union, N. J., and vice-president in charge of sales, has resigned to enter consulting work in industrial product analysis and market research. He remains active as a director and a member of the executive committee of the Elastic Stop Nut Corp.

◆

A. F. HUBER, chief engineer of the Ramapo Ajax Division of American Brake Shoe & Foundry Company, with headquarters at Chicago, has transferred his headquarters to Niagara Falls, N. Y. J. V. Houston, assistant chief engineer of Ramapo, will remain at his present location.

◆

AMERICAN LOCOMOTIVE COMPANY.—R. G. McAndrew, superintendent motive power, New York, Ontario & Western, has been appointed technical assistant to the vice-presidents in charge of engineering and manufacturing, American Locomotive Company, with office at Schenectady, N. Y. W. L. Lentz has been appointed manager of the Schenectady plant, succeeding R. P. Allison, who has been appointed manager of the plant at Richmond, Va.

R. G. McAndrew was born on February 25, 1895, at St. Thomas, Ont. He was graduated from the University of Michi-



R. G. McAndrew

gan with the degree of Bachelor of Science in mechanical engineering, and entered railroad service in 1916 as a special apprentice with the Michigan Central. From 1919 to 1923, Mr. McAndrew served as enginehouse foreman on the Michigan Central and from 1923 to 1928 was drafting, testing and enginehouse foreman on the Denver & Rio Grande Western. In 1929 he was appointed mechanical engineer of the New York, Ontario & Western and in 1937 became superintendent of motive power, with headquarters at Middletown, N. Y.

W. L. Lentz was born on January 29, 1895, at Jersey Shore, Pa. During 1917 and 1918 he attended military schools at Cornell University and Fort Sill, and was commissioned lieutenant in the aviation corps. He began service with the New York Central in May, 1913, completed an apprentice course in the locomotive shops and subsequently was assigned to road test work. In 1919 he was appointed apprentice instructor in the locomotive and car shops at West Albany, N. Y., and in May, 1920, was transferred to the equipment engineering department at New York, successively occupying the positions



W. L. Lentz

of designer, traveling inspector, assistant engineer of motive power and engineer of motive power. In January, 1937, Mr. Lentz became associated with the Standard Stoker Company, Inc., as sales manager, which position he held until his appointment as manager of the Schenectady plant of the American Locomotive Company.

◆

THE COFFING HOIST COMPANY, Danville, Ill., has moved its plant and offices into its recently constructed factory and office building.

◆

DR. CLAUDE L. CLARK, formerly of the Department of Engineering Research, University of Michigan, has joined the staff of the Steel & Tube division of the Timken Roller Bearing Company at Canton, Ohio, as metallurgical development engineer.

◆

HARVEY WILSON, formerly in charge of the Philadelphia sales office of the Babcock & Wilcox Tube Co., has been transferred to New York as district sales manager.

Obituary

MAX ROTTEN, at one time vice-president in charge of engineering of the Busch-Sulzer Brothers Diesel Engine Company, St. Louis, Mo., died in that city on October 6 of a heart ailment.

◆

WILLIAM VAN DOREN WRIGHT, former vice-president of the Edgewater Steel Company, died in Paris, France, on September 19, where he had been living since his retirement from that company in 1934. He was born in Indianapolis in September, 1871, and had been president of The Thiffault Company, treasurer of the Inter-Ocean Steel Co., and manager of the Chicago office of the Railway Steel-Spring Company.

◆

WILLIAM D. THOMPSON, sales representative of the Standard Railway Equipment Company, Chicago, died on September 6 near Birmingham, Mich., at the age of 67, after an illness of a year.

◆

C. A. MCCUNE, research engineer and secretary of the Magnaflux Corporation, New York, died at Atlantic City, N. J., on October 14.

◆

H. H. TIMKEN, co-founder of the Timken Roller Bearing Company and chairman of the board, died in Canton, Ohio, on October 14. Mr. Timken was born in



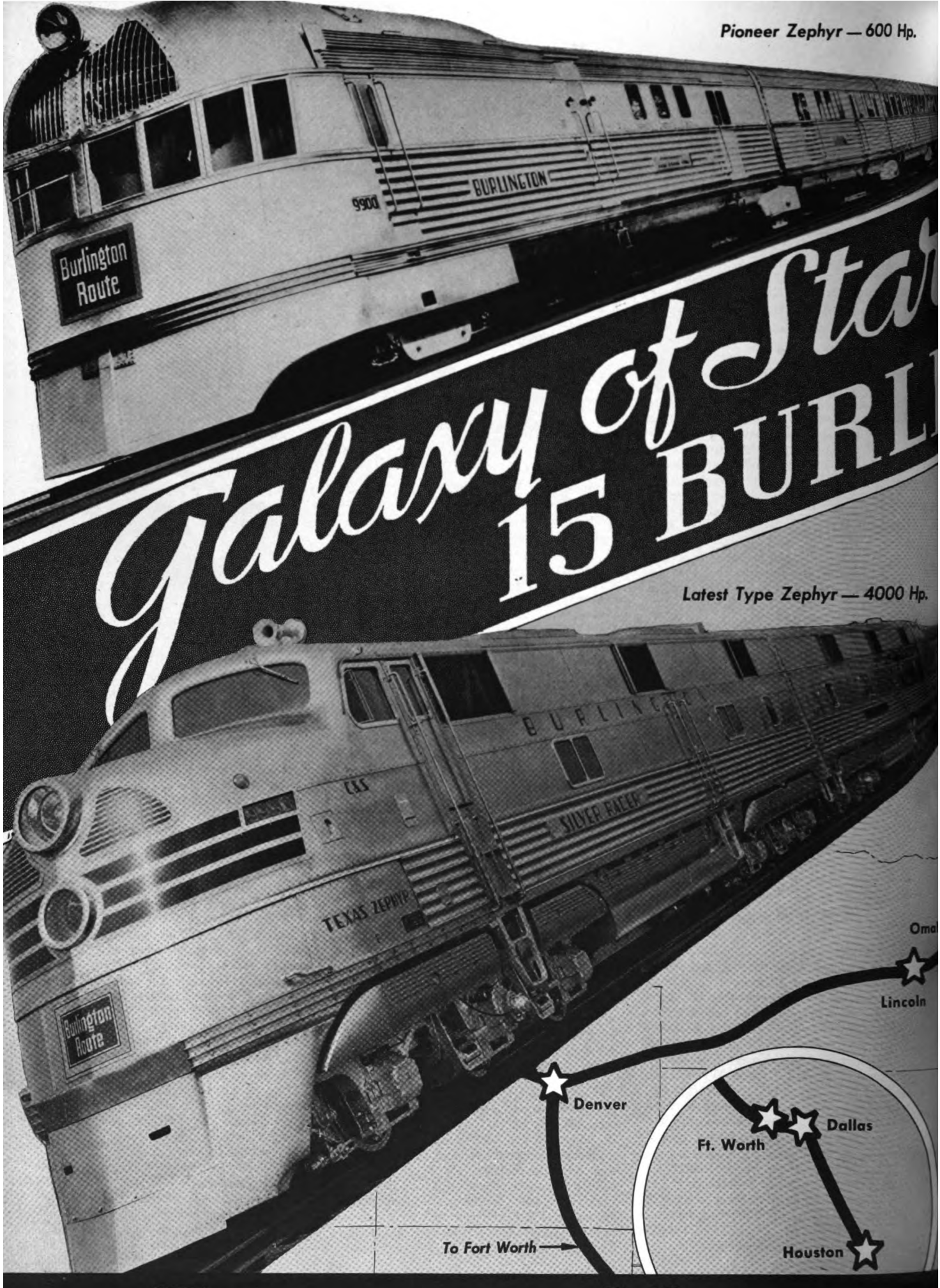
H. H. Timken

St. Louis, April 19, 1868, was a graduate of the University of California law school. He went to Canton in 1901 and, with his father established the Timken Roller Bearing Axle Company. In 1909 the firm took its present name. Mr. Timken was the first president of the Canton Chamber of Commerce and had been chairman of the board of Hercules Motor Corporation of Canton. He had been president of the Timken Roller Bearing Company for 23 years and chairman of the board for 12.

◆

J. E. BUKER, vice-president and a director of the Vapor Car Heating Company, Inc., and the Vapor Car Heating Company of Canada, Ltd., with headquarters at Chicago, died in that city on October 11 of a heart ailment. Mr. Buker was born in New York and began his railway career at an early age with the Lake Shore & Michigan Southern, now a part of the New York Central. Several years later, in 1889, he resigned to enter the employ of the Chicago, Santa Fe & California, now a part of the Atchison, Topeka & Santa Fe, at its Corwith shops in Chicago. Later he was appointed superintendent of the Hicks Stock Car Company, Chicago. In 1901 he resigned to become assistant superintendent of machinery of the Illinois Central at Chicago. In 1908, he was appointed superintendent of the car department. In 1910 he became a vice-president and director of the Chicago Car Heating Company, now the Vapor Car Heating Company. In 1905-1906, Mr. Buker was president of the Master Car Builders Association, and at the time of his death was a director of the Western Railway Club.

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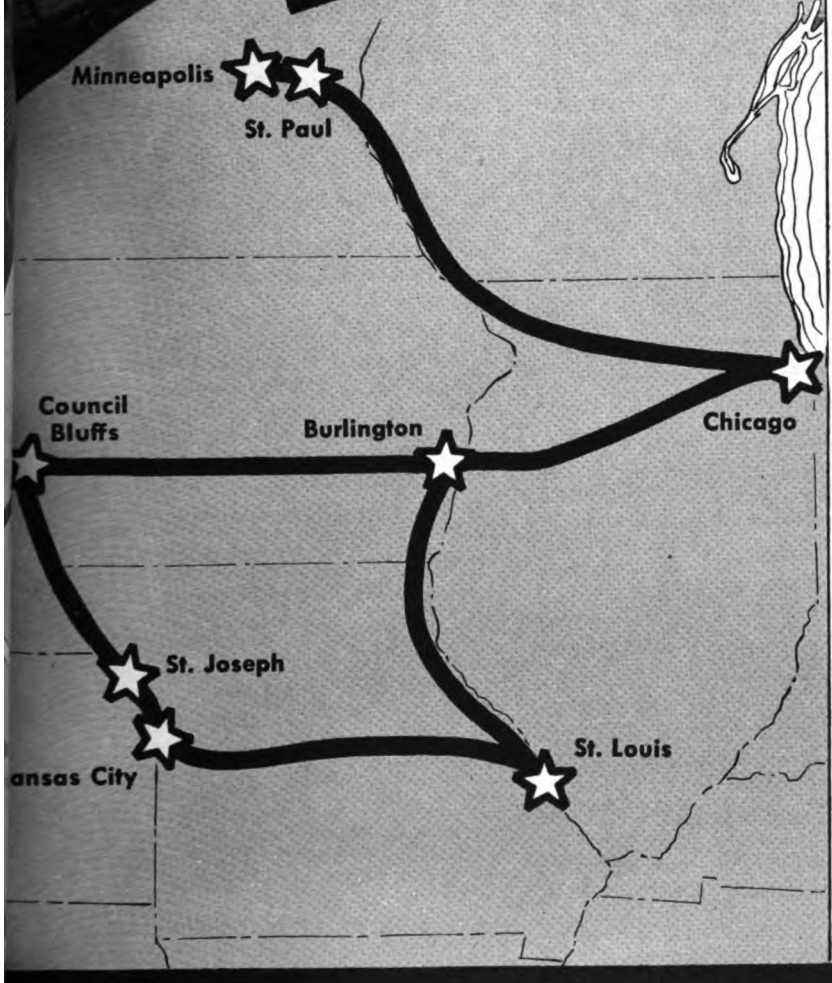
ELECTRO-MOTIVE

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DIESEL POWER

Performers
NGTON ZEPHYRS

Burlington Route



10,000,000 Miles Availability 97.6%

IN 1934 the Burlington "PIONEER ZEPHYR" made transportation history as America's first high speed Diesel-powered train and blazed the trail to improved passenger service. Larger power units and longer trains soon followed and today the Burlington Lines operate 15 Zephyrs — each a star performer with faster schedules — on-time arrivals—high availability—low operating cost and increased passenger travel.

These EMC Diesel-powered trains operate 11,084 miles daily, a total of over 4,000,000 miles annually. The mileage of all Zephyrs to September 1, 1940 totals over 10,000,000 with the high average availability of 97.6%.

Typically outstanding is the record of the "SAM HOUSTON ZEPHYR" No. 9901 which first entered service April 21, 1935 as a "TWIN CITY ZEPHYR" and operated 415,782 miles before being transferred to the Fort Worth-Houston service in September 1936. From September 30, 1936 to September 1, 1940, a period of 47 months, the 9901 operated 793,648 miles with 11 days out of service for annual inspections and 17 days for repairs on account of collision with a truck—an availability record of 98%.

CORPORATION
LA GRANGE, ILLINOIS, U. S. A.

Personal Mention

General

M. M. KELLY has been appointed superintendent of motive power and equipment of the Litchfield & Madison, with headquarters at Edwardsville, Ill.

R. W. RETTERER, mechanical engineer on the Cleveland, Cincinnati, Chicago & St. Louis, has been appointed assistant superintendent of equipment, with headquarters as before at Indianapolis, Ind.

W. D. DICKIE, division master mechanic on the Canadian Pacific at Calgary, Alta., has been appointed supervisor of machinery on war contracts, motive power and rolling stock department, with headquarters at Montreal, Que.

FRANK KENNETH MITCHELL, assistant superintendent of equipment on the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at Indianapolis, Ind., has been appointed assistant to general superintendent of motive power on the New York Central system, with jurisdiction over locomotive shops and Elkhart Foundry operations. His headquarters are at New York.

SAMUEL A. CHAMBERLIN, superintendent of motive power of the Lake Superior & Ishpeming, with headquarters at Marquette, Mich., retired on October 1. Mr. Chamberlin was born at Fox Lake, Wis., on March 27, 1867, and entered railway service on May 25, 1882, as a machinist at Saginaw, Mich., on the Flint & Pere Marquette (now part of the Pere Marquette), later becoming an air-brake foreman and enginehouse foreman on the Detroit, Lansing & Northern (now part of the Pere Marquette). In 1900, he was promoted to general foreman on the Pere Marquette at Muskegon, Mich., and a year later became master mechanic, serving in that capacity at Ionia, Mich., Grand Rapids and Saginaw. In 1914, he went with the Bureau of Valuation of the Interstate Commerce Commission as senior inspector of motive power and four years later was appointed senior mechanical engineer. Mr. Chamberlin was appointed superintendent of motive power of the Lake Superior & Ishpeming in April, 1919.

OTTO C. GRUENBERG, whose appointment as superintendent of motive power of the New York, Ontario & Western and the New York, Susquehanna & Western at Middletown, N. Y., was reported in the October *Railway Mechanical Engineer*, was born on August 1, 1897, at Gary, Ind. Mr. Gruenberg was graduated from Tri-State College in 1921 with a degree in mechanical engineering and from Harvard Summer School in 1930 in railroad transportation. From July, 1921, to May, 1922, he was department foreman of the American Sheet & Tin Plate Company at Gary, Ind., and from the latter date until July, 1925, served as special apprentice on the Chicago, Milwaukee, St. Paul & Pacific at Milwaukee, Wis., and Austin, Minn. Mr. Gruenberg became a draftsman on the C. M. St. P. & P. at Milwaukee in July, 1925, and in March, 1926, became enginehouse foreman at Sioux City, Iowa. In November, 1926, he was appointed dynamometer car engineer on the C. M. St. P. & P., going with the Boston & Maine in March, 1927, as general foreman at Springfield, Mass. From June, 1929, to May, 1933,



Otto C. Gruenberg

Mr. Gruenberg served as special engineer on research work for the B. & M. at Boston, Mass., becoming shop foreman at Mechanicville, N. Y., on the latter date. From January, 1935, to June, 1936, he was special engineer, conducting locomotive tests, and enginehouse foreman. He served in the engineering department of the American Locomotive Company at New York, making motive power studies, from June, 1936, to October 1, 1940, when he was appointed superintendent of motive power of the New York, Ontario & Western and the New York, Susquehanna & Western.

Master Mechanics and Road Foreman

FRED J. FAHEY, master mechanic on the New York Central at Albany, N. Y., has been appointed assistant superintendent of equipment, with headquarters at New York, succeeding Charles F. Parsons, who has retired.

E. C. MITCHELL has been appointed assistant road foreman of engines of the Chesapeake & Ohio, with headquarters at Ashland, Ky.

L. LENOSKI, general locomotive foreman of the Canadian Pacific at Winnipeg, Man., has been appointed division master mechanic at Calgary, Alta.

FRED WALLER, general foreman of the mechanical department of the Lake Superior & Ishpeming, has been appointed master mechanic, with headquarters at Marquette, Mich.

P. R. MITCHELL, master mechanic of the Louisville & Nashvillle at Ravenna, Ky., has been appointed master mechanic at Howell, Ind.

FRED H. RENNER has been appointed assistant master mechanic of the New York Central at Albany, N. Y.

C. F. DENO, division master mechanic of the Canadian Pacific at Regina, Sask., has been transferred to Winnipeg, Man.

DONALD M. SMITH, division master mechanic of the Canadian Pacific at Winnipeg, Man., has been transferred to Regina, Sask.

JOHN F. RYAN, day enginehouse foreman and general foreman of the Louisville & Nashville at Ravenna, Ky., has been promoted to the position of master mechanic at Ravenna.

CHARLES A. PEASE, assistant master mechanic of the New York Central at Albany, N. Y., has been promoted to master mechanic, with headquarters at Albany.

CHARLES GREEN has been appointed assistant master mechanic of the Western division of the Southern Pacific, with headquarters at West Oakland, Cal.

Shop and Enginehouse

C. N. SWARTWOOD has been appointed shop superintendent of the Erie at Dunmore, Pa.

N. J. BRICHER, general foreman of the car department on the Chicago, Burlington & Quincy at Aurora, Ill., has been promoted to superintendent of shops at that point, succeeding H. C. Gugler, deceased.

SAM VICK, machinist and crane operator of the Louisville & Nashville at Ravenna, Ky., has been transferred to the position of foreman in the mechanical department at Jackson, Ky.

JESSE T. NOLAND, night enginehouse foreman of the Louisville & Nashville at Ravenna, Ky., has been promoted to the position of day enginehouse foreman at Ravenna. The position of general foreman at Ravenna has been abolished.

Car Department

K. E. LIND has been appointed general foreman of the Erie at Dunmore, Pa.

L. E. SCHUETTE has been appointed division car foreman of the Erie, with headquarters at Brier Hill, Ohio.

Obituary

H. C. GUGLER, superintendent of shops on the Chicago, Burlington & Quincy at Aurora, Ill., died at that point on September 20.

H. G. BECKER, shop superintendent on the Delaware & Hudson, with headquarters at Colonie, N. Y., died on October 10 at Albany hospital, after an operation. He was 55 years old.

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Volume 114 *No. 12*

Locomotive:

High-Speed Locomotive Cylinder Power Measurement 526

Car:

K. C. S.-L. & A. "Southern Belle" 523
Lightweight All-Welded C. M. St. P. & P. 50-Ton Box Cars 528

General:

Factors Influencing the Service of Firebox Materials 531
Two Jobs for Every Railroad Man 536
New Nathan Injector 540

Editorials:

Detailed Car Repair Costs 541
Railroad Rolling Stock Being Reconditioned 541
Boilermaking With Micrometers 541
Applying Locomotive Crank Pins 542
What Is a Railroad? 542

Backshop and Enginehouse:

A. C. L. "Igloo" Sand Drying House 544
Laying Out Shoes and Wedges on a Vertical Turret Lathe 545
Locomotive Boiler Questions and Answers 545
It's An Ill Wind (A Walt Wyre Story) 546
Flexible, Seamless All-Metal Hose 549

Car Foremen and Inspectors:

Pipe and Air-Brake Shop Devices 550
Repairing Box-Car Couplers and Draft Gears 553
Air Brake Questions and Answers 553
A Versatile Railway Crane 554
Mechanical Lubricator for A. A. R. Journals 554

High Spots in Railway Affairs 555

Among the Clubs and Associations 556

News 557

Index to Advertisers (Adv. Sec.) 44

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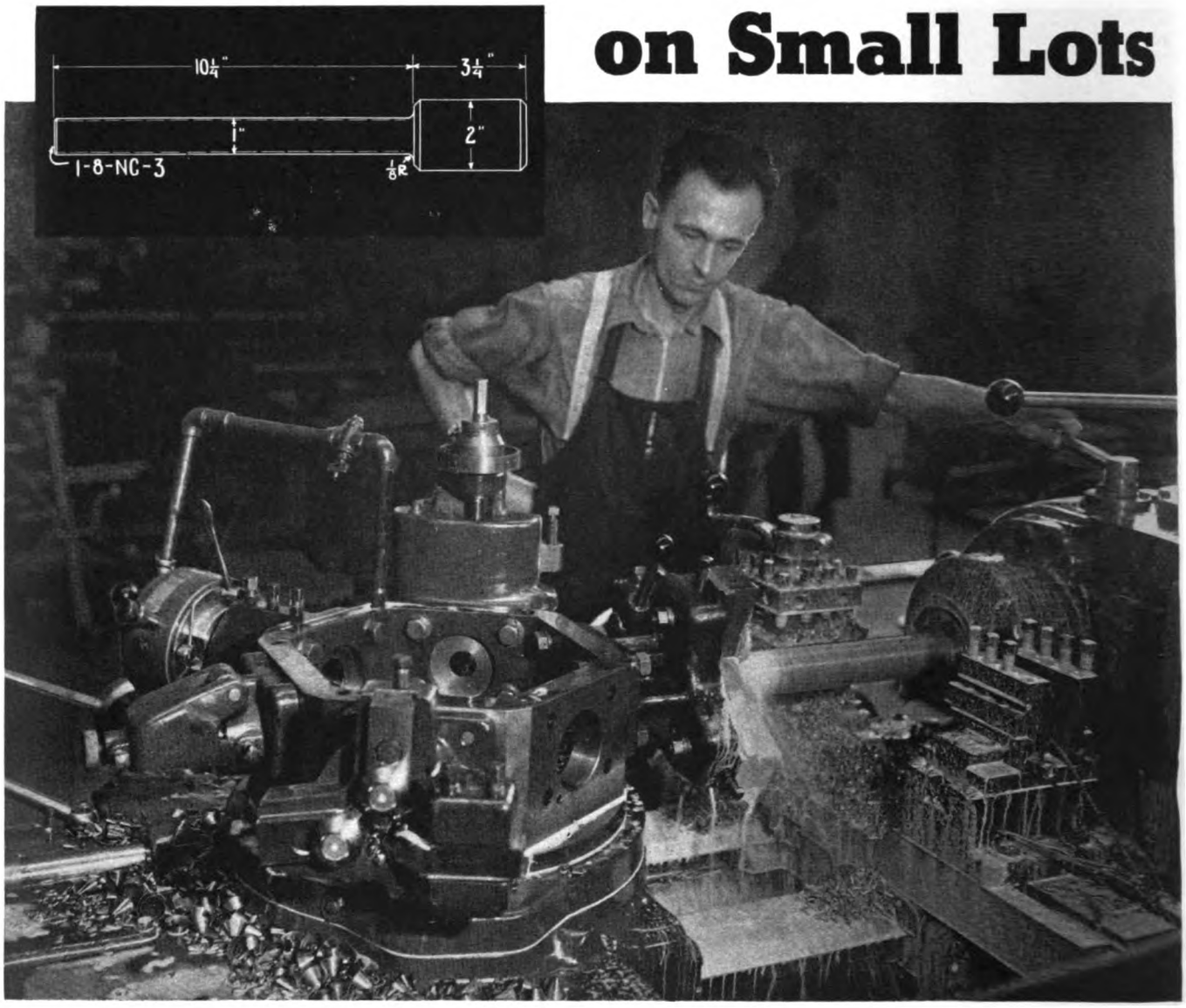
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This new 7A Jones & Lamson Saddle Type Universal Turret Lathe is machining these Threaded Rods in less than half the time required by the older type machine, previously used. High spindle speeds and great rigidity get the most out of the carbide tipped turning tool on this type of work. Note the copious supply of coolant to the tool directly from the hexagon turret.

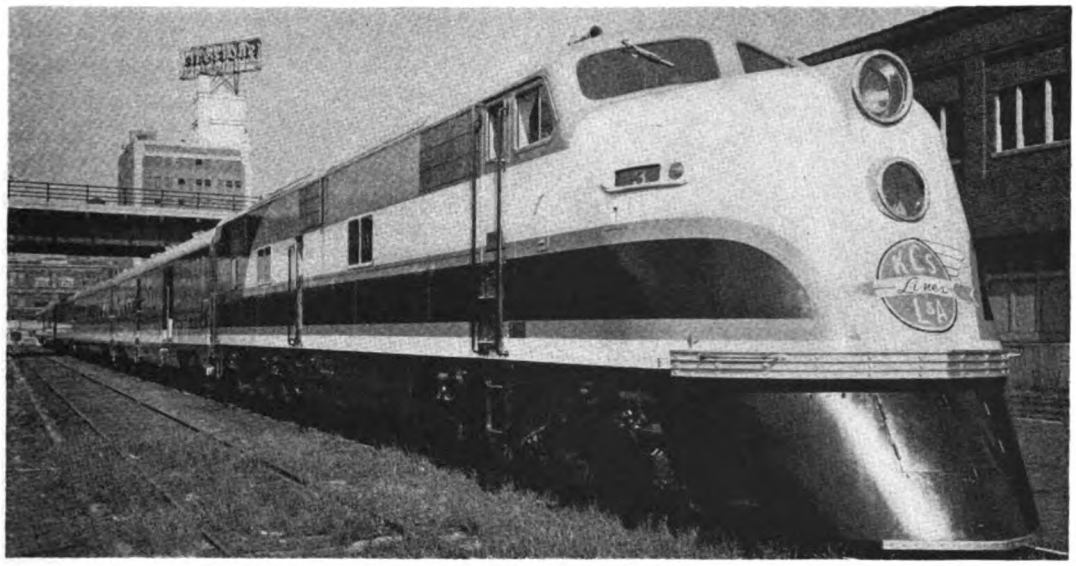
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MANUFACTURERS OF: SADDLE & RAM TYPE UNIVERSAL TURRET LATHES . . . FAY AUTOMATIC LATHES . . . AUTOMATIC DOUBLE-END MILLING & CENTERING MACHINES . . . AUTOMATIC THREAD GRINDING MACHINES . . . COMPARATORS . . . TANGENT AND RADIAL, STATIONARY AND REVOLVING DIES AND CHASERS



K.C.S.-L. & A. "Southern Belle"

Three four-car trains built of aluminum alloys and driven by Diesel-electric locomotives

EARLY in September the Kansas City Southern-Louisiana & Arkansas Lines placed in operation between Kansas City, Mo., and New Orleans, La., the new four-car passenger-streamliner Southern Belle.

The schedule calls for 25 stops in the 868-mile run between terminals, the overall running time being 21½ hr. and the average speed slightly over 40 miles an hour.

To maintain daily schedules in each direction, three Southern Belle trains are required. Each train consists of a Diesel-electric locomotive, a mail-baggage car, a chair car, a Pullman sleeper, and an observation-parlor-diner car. The single-unit 2,000-hp. locomotives were furnished by the Electro-Motive Corporation. The cars for each train were designed and built by the Pullman-Standard Car Manufacturing Company, strong aluminum alloy being used as the principal structural material to secure a high strength-weight ratio. Individual car dimensions, weights and seating capacities are given in one of the tables.

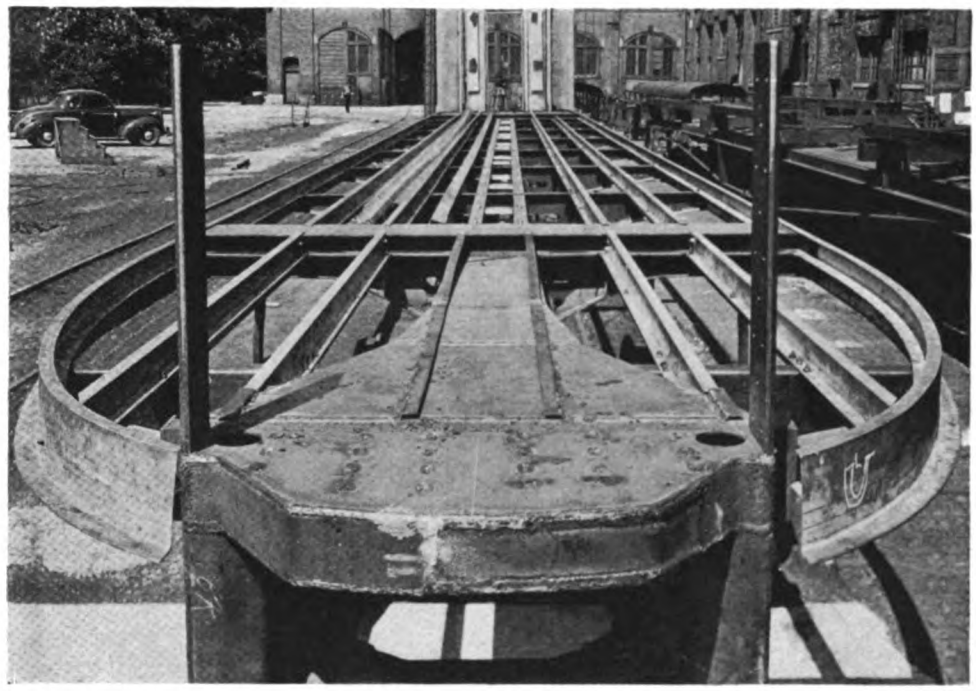
Both the exterior and interior of the Southern Belle were designed by Pullman-Standard stylists in close co-operation with Harvey Couch, chairman of the board of the K. C. S.-L. & A. The exterior design presents the latest refinements in structural streamlining, accented by the use of a striking and unusual color scheme. The front end of the Diesel-electric locomotive uses vivid red and yellow for visibility, in contrast to the dark green background. The red and yellow are carried in sweeping curves, giving an impression of speed and power, and adding materially to the streamline effect.

The cars have aluminum-colored roofs, with the car bodies in dark green, and carry at the girder sheet a wide yellow stripe with a wide vivid red stripe placed just above. These striping colors are carried in uninterrupted lines from the locomotive, giving the effect of continuity to the train, and by this use of color making a striking and complete unit of the train in its entirety. The aluminum of the roof is separated from the dark green of the car body by a narrow red stripe, and the exterior lettering on the train is in imitation gold color.

The interior design of the passenger cars creates an impression of extreme simplicity, coupled with efficiency and good taste in selecting materials and decorations.

Special features of the car equipment include Pullman electro-mechanical air conditioning; large wash rooms and luggage compartment at each end of the chair car, allowing a more advantageous spacing of seats; a day room and secretary's room in the observation-lounge-diner car for convenience of passengers and crew; a settee on one side of the aisle and seats with table on the other in the front part of the chair car for convenience and comfort of passengers; photo-murals in the observation-lounge-diner car and chair cars showing scenes along the route; master radio with speakers in all parts of the train, each speaker equipped with variable volume control; telephone connection for use with regular Bell system during stops along the line; large clock in observation-lounge-diner cars and chair cars; telephone connection between all cars and the locomotive for inter-train communication; private office for conductor at the front of each chair car equipped with desk, cabinet for papers, telephone for communication with engineman and other cars; wash room, including shower bath, for crew in mail-baggage car.

The observation-lounge-dining car is divided into six



An observation-car underframe in process of construction

main sections, from front to rear: two day rooms, 10 ft. 7 in.; lunch room, 7 ft.; kitchen, 11 ft. 4 in.; dining room, 12½ ft., seating 16; parlor, 17½ ft., seating 17; and observation room, 11½ ft., seating 8.

Many details designed to increase the comfort and convenience of the passengers have been incorporated in the chair cars. The seating capacity of each chair car is 74, 56 in the 48-ft. white compartment and 18 in the 17-ft. colored compartment.

The baggage compartment in the front half of the mail-baggage car is 38 ft. 4 in. long. A partition with a low creep door separates it from the 30-ft. mail compartment, which is equipped with Railway Mail Service racks, compartments, etc., for working mail while the train is enroute.

A 9-ft. 9¾-in. section at the rear of the car is designed to supply comfortable sleeping and toilet accommodations for the crew.

One sleeping car is operated in the southbound train from Shreveport to New Orleans, and another sleeper in the northbound train from New Orleans to Shreveport. The sleeping cars are of the ten-section, three-double-bedroom floor plan.

Lighting

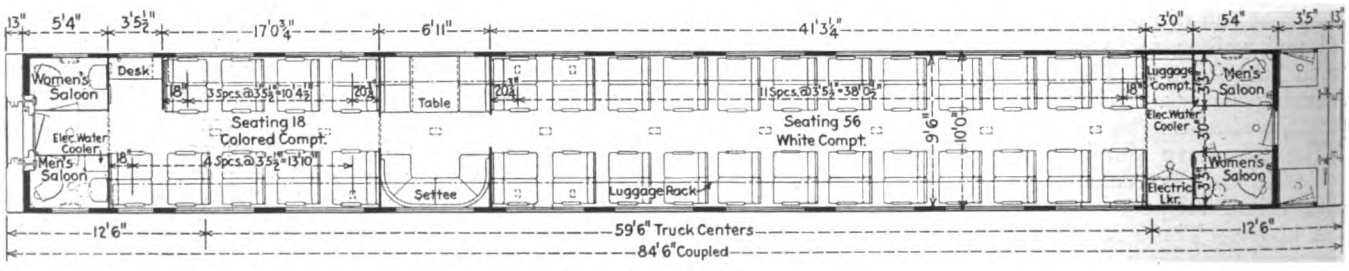
The chair cars have individually controlled lights placed on the lower side of the basket racks, one light to each seat. In addition to this, and for general illumination, center lights are used at the ceiling and, by a unique lens system, are so designed to focus the light on the aisle only. These lights are glareless to the passengers, even though the passengers may be in reclining positions. Blue night lights are also provided to give further distinction to the lighting system.

The same general type of controlled-lens lighting is used in the vestibules, passageways, lunch room and day rooms, and in the observation room. In the lunch room and observation room these lensed ceiling units are arranged in a pattern to follow the room contour of the observation end and the lunch counter contour in the lunch room, and are further accented by satin-finish snap moldings placed on either side, with a distinctive color band in the central portion.

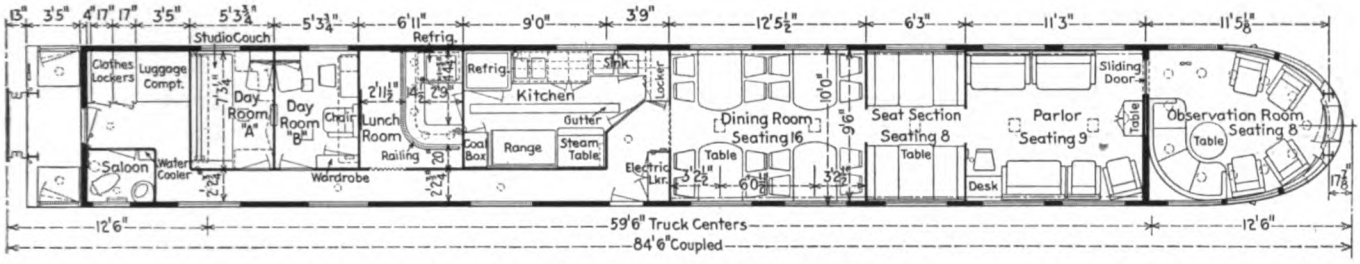
The dining room and lunch room, in addition to the lensed center lighting, have continuous side lighting running from bulkhead to bulkhead, placed just over the windows on either side of the room. This gives a very decorative effect because the light is directed up to the ceiling and down to the dining tables and lounge furniture through translucent plastics. To add further to the appearance, strips of the same plastic material are inserted in the front of the fixture, thus creating luminous lines running the length of the unit.

Construction Details

The 11 railroad-owned cars, consisting of 3 mail-and-baggage cars, 5 chair cars and 3 observation-parlor-diner cars, embody the same general structural design and are made of fabricated aluminum alloys, except for the draft sills, bolsters, end sills, and cross ties, draft lugs and diaphragm post reinforcements, which are of alloy steel. The shell weight of one of the coaches, as determined by track scales, was only 20,113 lb. The car structure is designed to comply with the present requirements of



Floor plan of the coach



Floor plan of the observation-parlor-diner

the Association of American Railroads for new passenger cars, including resistance to minimum static end load of 800,000 lb. applied on the center line of draft. The cars are of riveted construction, all exposed rivets being aluminum with mushroom-type heads.

The general type of underframe consists of two main center sills of 12-in. aluminum-alloy channels, reinforced with ⅝-in. aluminum-alloy bottom plate. These center sills extend from bolster to bolster. The bolsters and end construction are welded alloy steel. Floor stringers, false floor and main floor consist of aluminum alloys. The main floor is Pullman arch construction, with Fiberglas insulation and lightweight composition flooring. Linoleum is applied in the chair cars and carpet in the observation-parlor-diner. All threshold plates are made of cast aluminum, with special anti-skid surface.

Principal Dimensions and Weights of "Southern Belle" Aluminum Alloy Cars

	Mail—baggage	Chair car	Observation—Parlor—diner
Length over buffers, ft.	84½	84½	84½
Width over side posts, ft.	10	10	10
Roof height above rails, ft.	13½	13½	13½
Truck centers, ft.	59½	59½	59½
Truck wheel base, ft.	9	9	9
Journal size (roller bearings), in.		5½ by 10 (all cars)	
Seating capacity	...	74	41
Body light weight	58,900	66,750	67,750
Truck weight (2)	37,300	38,000	38,000
Total light weight	96,200	104,750	105,750
Water, ice, provisions, etc.	2,000	2,000	6,500
Weight ready for service	98,200	106,750	112,250

The side framing is of the self-supporting type, riveted-girder design, of aluminum-alloy sheets and shapes, with skirts below the side sills separately applied. The vestibule construction for the wide and dummy-type vestibules also is made of aluminum alloys. The turtle-back type of roof is continuous from end to end of the cars, without hoods, except the rear end of the observation-parlor-diner cars, which have a sloping hood to conform to the streamline shape of the train.

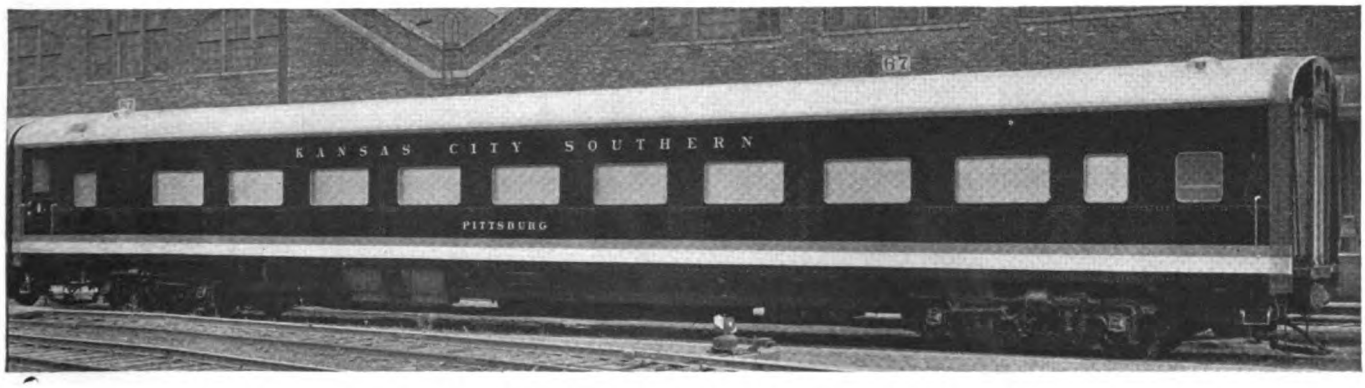
The cars are completely insulated with Fiberglas insulation, held in place with aluminum bands. All safety appliances have been provided to meet Interstate Commerce Commission requirements for these types of cars.

The draft gear, buffing device, and drawbars are of the A. A. R. tight-lock type, with integral yoke, designed to absorb lost motion and provide easy starting and stopping characteristics without jerk or jar. The vestibule side doors, of the Pullman pivoted-type, operating in conjunction with trap doors, are arranged to close up and hide the steps when the doors are shut. All steps

(*Continued on page 539*)



Interior of one of the chair cars



The cars have straight and smooth car sides, wide windows and are finished in brilliant colors

Cylinder-Power Measurement[1]

By L. K. Botteron[2]

The limitations of mechanical indicators in determining the indicated horsepower of high-speed locomotives—The heat-drop method employed by the Union Pacific in road tests

STEAM locomotives now run for short periods at speeds in excess of 100 m. p. h. Speeds of 90 m. p. h. for sustained periods are not unusual. Running over a division at 75 m. p. h., with the exception of the acceleration and deceleration periods in stopping, starting, and observing local speed restrictions, is common practice. At diameter speed, the driving wheel rotates at 336 r. p. m.; high-speed passenger locomotives operate a considerable part of the time at higher than diameter speeds. Considering the size of locomotive cylinders, the rotational speeds are high as compared with other reciprocating engines.

The difficulties encountered in taking indicator cards on high-speed steam locomotives are many and it must be borne in mind that, compared with indicating stationary engines, the problems encountered are far more complex. Reducing motions are a constant source of trouble due to breaking and rapid wear as they must run unprotected from the weather. Due to roadway clearances and interferences of locomotive parts, it is often difficult to apply any sort of a reducing motion. Common to all indicators driven with a reducing motion, the stretching of the indicator cord increases as the speed increases, the indicator-drum spring is hard to adjust correctly, and even the drum is a source for errors due to its inertia. L. Pendred, in an article [3] on high-speed indicators, does not believe any reciprocating reducing motion is reliable above 500 r. p. m. In the case of steam locomotives, this limit more likely would be 300 r. p. m. Mechanical indicators of simple and rugged construction for speeds up to 500 r. p. m. are on the market but, if the indicator-drum motion does not proportionally follow the crosshead, the cards are of little or no value.

Since reducing motions, cord stretch, and drum inertia are such a source of error, the thought arises that it might be better to dispense with the reducing motion entirely and drive the drum at constant speed in one direction. In this case it would be necessary to apply an apparatus for marking crosshead dead centers on the card. Also, the drum speeds would have to be high as shown by the following example:

A locomotive with 80-in. drivers, at a speed of 100 m. p. h. is making 420 r. p. m., which completes a cycle in 1/7 sec. To obtain cards 3 in. long, paper travel of 1¾ ft. per sec. would be required.

The errors common to the mechanical indicator are well covered in technical literature. On the steam locomotive, all of the mechanical-indicator errors and troubles common to stationary work are encountered plus some additional ones. The most troublesome of these are the severe rapid vibrations of the front end of the locomotive at high speeds. Front-end vibration will in turn vibrate the entire indicator and especially disturb the pencil motion. Sticking pistons are common, due to highly superheated steam and bits of boiler scale and other foreign matter getting into the indicator cylinder. The operator labors under conditions which are not conducive to good work and, furthermore, there is the hazard of striking obstacles such as vehicles or animals. There is also the possibility of the locomotive meeting with an accident that would result in knocking out a cylinder head.

Due to clearance limits, indicators usually cannot extend out beyond the width of the cylinders. This means that indicators cannot be connected directly into the cylinders. Instead, relatively long pipes must be used between the cylinder and the indicator in order to locate the instrument so that it is accessible to the operator and within clearance limits. The errors due to long pipes are very serious and at high speeds the events, as shown by the card, lag so far behind the actual events in the cylinder as to make the card valueless both for the events and for the determination of the mean effective pressure.

Mechanical indicators, developed primarily for internal-combustion-engine testing, offer possibilities for high-speed steam-locomotive testing, provided the drum is driven at constant speed and not by a reducing motion. However, the errors due to long pipes and locomotive vibration would still be present, and the operator would have to ride the front end. Pressure-time cards instead of pressure-volume cards would be obtained and, to determine the m. e. p., it would be necessary to redraw the cards on a pressure-volume basis unless a special integrator were available.

Optical indicators do not seem to offer any possibilities for locomotive road tests. They are essentially laboratory instruments and are not rugged enough to stand shocks and vibrations.

Electrical-Type Indicator

The indicator which offers possibilities for determining the indicated horsepower of high-speed steam passenger locomotives is the electrical type, such as the Martin and Caris indicator,[4] the indicator described by H. T. Sawyer,[5] and the indicator advertised by the General Electric Company.[6] With the electrical indicator, the only apparatus required on the locomotive are the pressure-measuring heads, an electric dead-center marker, and wiring running back to the test car. The oscillograph, which is the recording instrument, would

[1] Abstract of paper contributed by the Railroad Division and presented at the semi-annual meeting of the American Society of Mechanical Engineers, at Milwaukee, Wis., on June 17-20, 1940.
[2] Engineer of road tests, Union Pacific.
[3] "High-Speed Engine Indicators," by L. Pendred, Engineering, vol. 115, January 26, 1939, pp. 119-121.
[4] "A New Electrical Engine Indicator," by E. J. Martin and D. F. Caris, S.A.E. Journal, vol. 23, July, 1928, pp. 87-97.
[5] "An Indicator for High-Speed Engines," by H. T. Sawyer, Mechanical Engineering, vol. 58, May, 1936, pp. 283-285.
[6] "To Measure Pressure Electrically," advertisement of General Electric Company, Mechanical Engineering, November, 1939, ad. p. 7.

be carried on the test car. The electrical indicator therefore possesses many inherent advantages over other types. The pressure-measuring heads are attached directly to each head of each cylinder, thereby eliminating the error due to piping; any number of cylinders can be indicated simultaneously; reducing motion is not used, and the operator is not required to ride the front end.

Conditions which might interfere with the accuracy of the electrical indicator are the effects of vibration and temperature differences on the pressure-measuring heads. The electrical indicator makes only pressure-time cards, but with a special integrator the m. e. p. of such cards may be directly determined.

Heat-Drop Method of Measuring Indicated Horsepower

Due to the limitations of mechanical indicators and the hazard of men riding the front end, the research and mechanical-standards department of the Union Pacific has used the heat-drop method for determining the steam rates and indicated horsepower of high-speed steam passenger locomotives. The methods of Arthur Williams [7] have been followed and the results obtained for high-speed work have been found to be reasonably accurate.

Briefly, the heat-drop method is based on the first law of thermodynamics. Thus in the case of the steam locomotive, the difference between the total heat in the steam to the cylinders and the steam exhausted from the cylinders is converted into mechanical work regardless of the processes which go on in the cylinder. The question has been raised as to the proper location of thermocouples for measuring exhaust-steam temperatures and it has been pointed out that the state of the steam during the exhaust period is variable.[8] The most reasonable location for the exhaust-steam thermocouples is in the exhaust-nozzle stand, since the exhaust pressure at that point has the least pulsation and the steam has had time to mix. The heat content of the exhaust steam cannot change between the valve chamber and the exhaust stand except for the influence of radiation and kinetic energy. If these two items are corrected for and the pressure and the temperature of the exhaust steam are accurately determined in the exhaust stand, it seems that a reasonably accurate determination might be made of the total energy.

The heat-drop method determines the steam rate only. In order to calculate the indicated horsepower, it is necessary to know the steam to the engine as well as the steam rate.

Knowing the pressure and temperature of the steam in the exhaust-nozzle stand, it is a simple matter to calculate the flow through the nozzle, provided the coefficient of discharge is known. Of course, all formulas for steam flow are based upon steady conditions and some doubt will arise as to whether the formulas hold true for locomotive conditions where the flow is pulsating. For low speeds, the pulsations are of such magnitude that the flow computed from the back pressure will be high. However, at high speeds, the exhausts are so frequent and the pressure fluctuations of such small magnitude that the gage will read an average pressure, accurate enough for calculating the flow.

The exhaust-pressure gage should be piped up so as to have a constant hydrostatic head. This can be done by running a pipe vertically from the side of the nozzle stand through the smokebox and terminating the pipe within the clearance limits. At this point, a coil of copper pipe is connected into the vertical pipe and a pipe with a gradual drop is run from the coil to the gage in the cab. The vertical pipe should be one inch or larger to be self-draining. Either a mercury manometer or a suitable Bourdon-tube gage may be used for indicating exhaust pressure in the cab.

A potentiometer will be found to work very satisfactorily for the determination of the temperatures, if the galvanometer is removed from the instrument and attached to the data board which is held by the operator when taking readings. Arthur Williams in his paper [7] illustrates and discusses such a mounting. During a test it is imperative to remove all auxiliary exhausts from the exhaust passages, as the exhaust steam from the auxiliaries is in a different state from the exhaust steam from the engines. Of course the exhaust-steam temperature taken in the exhaust stand must be the temperature of the exhaust steam from the engine only. Also, by removing the auxiliary exhausts from the exhaust passages, the steam to the engines equals the steam through the nozzle in the case of locomotives equipped with live-steam injectors while, in the case of locomotives equipped with feedwater heaters, the steam to the engines equals the steam through the nozzle plus the steam condensed from the exhaust passages for feedwater heating.

No definite data can be given which will cover the coefficients of discharge of locomotive-exhaust nozzles due to such a wide variety of nozzles being used. Each railroad would have to determine the characteristics of its own nozzle. In general, it will be found that for steady conditions round-hole nozzles without sharp edges or projections and having a smooth approach in the stand have coefficients of about 0.97 to 0.98 for their entire pressure range, while nozzles with complicated shapes and sharp edges have coefficients of 0.8 and lower at low back pressures with the coefficient increasing up to a maximum of about 0.93 at a pressure of 12 lb. per sq. in.

The author calculated the flow through the plain round-hole exhaust nozzle of Baldwin locomotive No. 60000, considering the flow adiabatic and using a coefficient of discharge of unity, but making no allowance for the velocity of the steam in the exhaust pipe.[9] The calculated results, compared with the test-plant measurements, show that, for exhaust-pipe pressures from 9.1 to 19.8 lb. per sq. in., calculated flows are from 3.59 per cent too high to 3.42 per cent too low, with an average of 0.62 per cent too low.

Equipment and Procedure for Heat-Drop Method

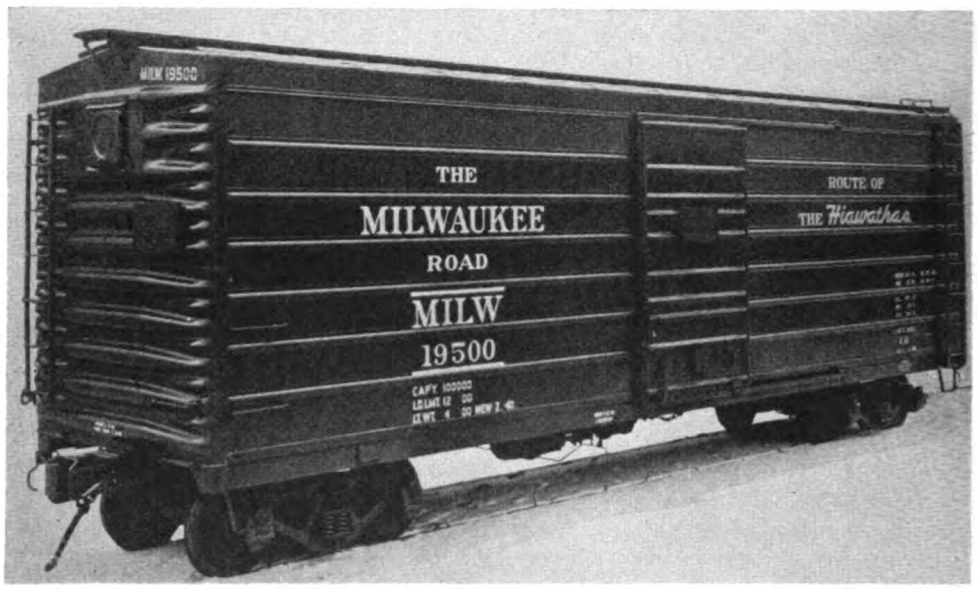
The equipment and procedure required for the use of the heat-drop method are simple. It is only necessary to measure steam-pipe and exhaust-stand pressures and temperatures accurately.

The indicating potentiometer is a simple rugged instrument. If any wiring becomes broken, disconnected, or grounded, the potentiometer galvanometer cannot be balanced. Thus there is no possibility of false readings. Only one operator is required and by placing the potentiometer and pressure gages in the cab the operator is removed from the front end to a safer location. The heat-drop method has the advantage over all other methods as it determines both instantaneous steam rate and indicated horsepower. A set of readings can be worked up in about 20 min.

[7] "Measurement of Steam Rate and Indicated Horsepower of Locomotives," by Arthur Williams, Trans. A.S.M.E., vol. 57, 1935, p. 495. An abstract of this paper was published in the January, 1936, issue of the *Railway Mechanical Engineer*.

[8] "Measurement of Steam Rate and Indicated Horsepower of Locomotives," by Arthur Williams, discussion, Trans. A.S.M.E., vol. 58, 1936, pp. 250-256.

[9] "Locomotive Back Pressure," by L. K. Botteron, *Railway Mechanical Engineer*, vol. 104, July, 1930, pp. 400-403.



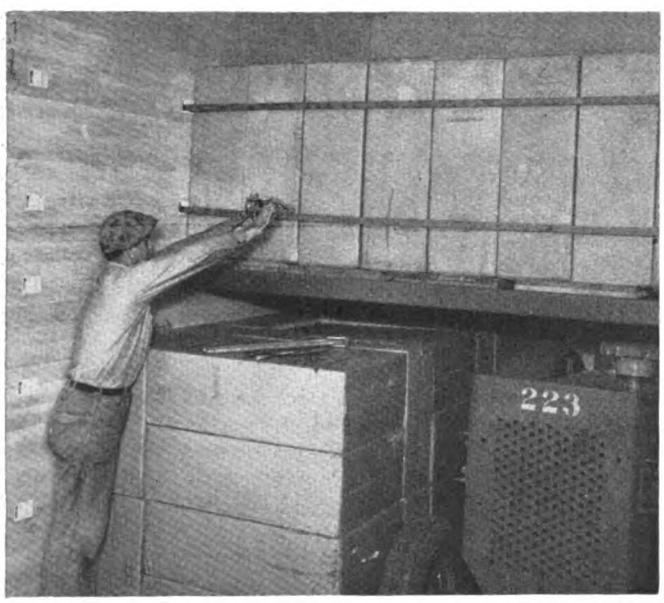
Lightweight, All-Welded

C.M.St.P. & P. 50-Ton Box Cars

Double-deck loading arranged for in 25 cars—Eighteen have special fabricated steel floor plates

DOUBLE-deck, or even triple-deck, loading can be made in 25 of a lot of 3,188 50-ton, 40-ft. 6-in. box cars recently completed at the Milwaukee, Wis., shops of the Chicago, Milwaukee, St. Paul & Pacific. Except for length, the use of two cross-bearers instead of four, door arrangement, and other minor refinements, the 3,188 cars are fundamentally the same in construction as the automobile cars described in the July, 1937, *Railway Mechanical Engineer,* page 327. They are of the double-sheathed, all-welded type, light weight being obtained by the use of low-alloy high-tensile steels in the underframes, sides, and lower section of the two-piece steel ends. Eighteen of the 3,188 cars have special fabricated steel floor plates which cover the entire wood floor and are perforated with round holes. To prevent moisture and dirt getting into these openings a special asphalt is used having a consistency soft enough to allow driving of nails. These plates, supplied by the Standard Railway Equipment Company, are designed to form a permanent floor construction which will require no further maintenance cost throughout the life of the car.

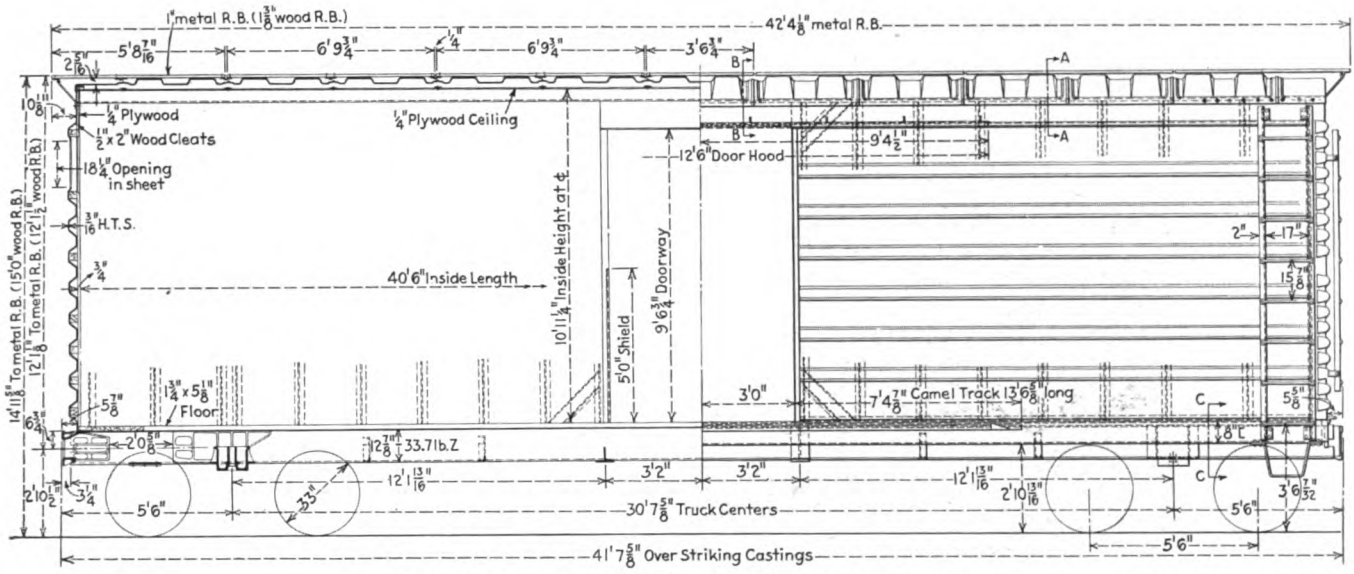
The sides of all of the cars are of No. 15 gage sheets having six ribbed sections running the full car length. The formed sections of the framing structure were assembled and welded together on a hydromatic spot welder. The steel ends have reinforced corner posts and the lightweight Z-26 center sills are of special steel composition. Additional Z-pressing supports give added strength to the floor. Lightweight cast-steel striking castings and bolster center fillers are attached to the



Flexible steel straps hold the upper deck load securely in place

Principal Dimensions and Weights of New Milwaukee 50-Ton Box Cars

Inside length	40 ft. 6 in.
Inside width	9 ft. 2 in.
Inside height at eaves	10 ft. 6 in.
Inside height at center	10 ft. 11¼ in.
Width of side door opening	6 ft.
Length over striking casting	41 ft. 7⅝ in.
Length between truck centers	30 ft. 7⅝ in.
Cubical capacity	3,898 cu. ft.
Weight capacity nominal	100,000 lb.
Light weight	42,600 lb.
Load limit	126,400 lb.
Ratio of load limit to gross load	74.8 per cent
Ratio of light weight to cubic capacity	10.93 lb. per cu. ft.



General arrangement of one of the new Milwaukee 50-ton box cars

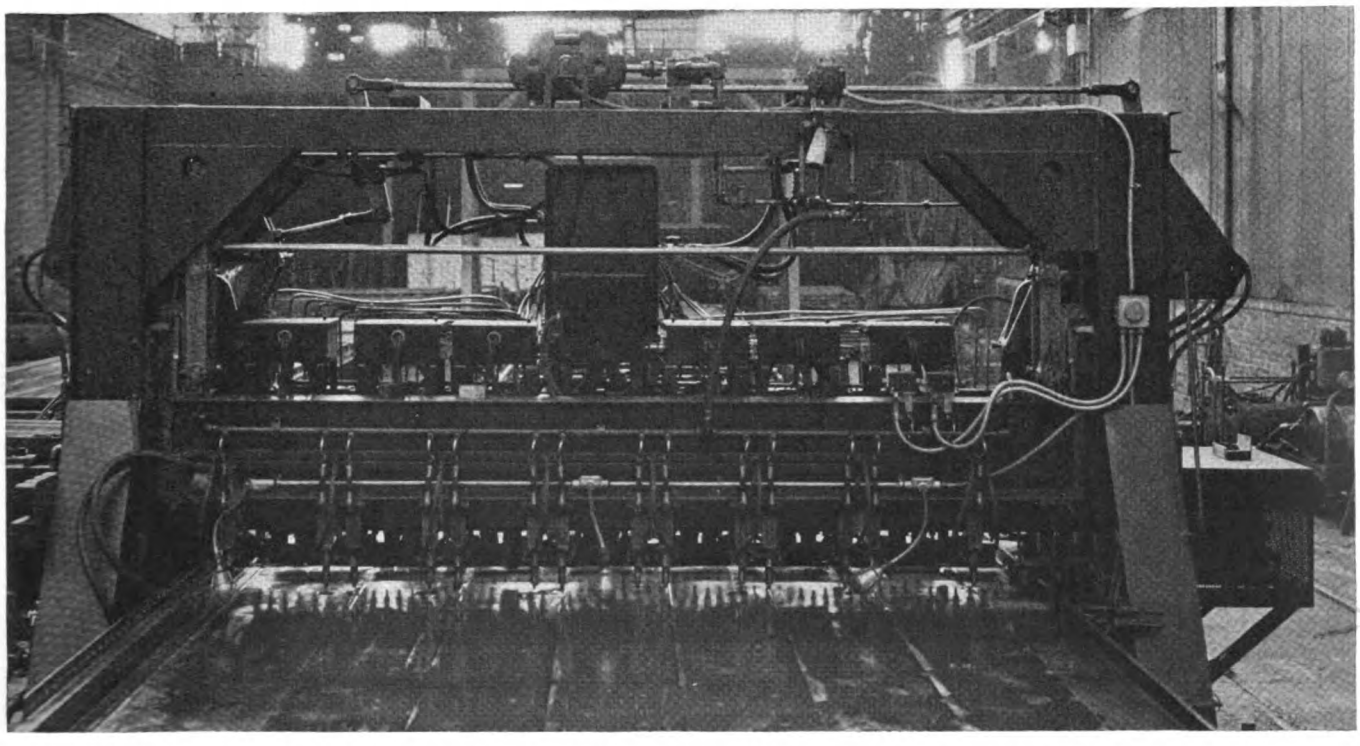
center sill by welding. The ceilings are of Douglas fir plywood. The side and end lining, also of Douglas fir tongue-and-groove lumber, is arranged with clean-out boards which can be taken out to remove grain, etc., which may find its way behind the lining.

The cars are equipped with Barber stabilized trucks and AB brakes.

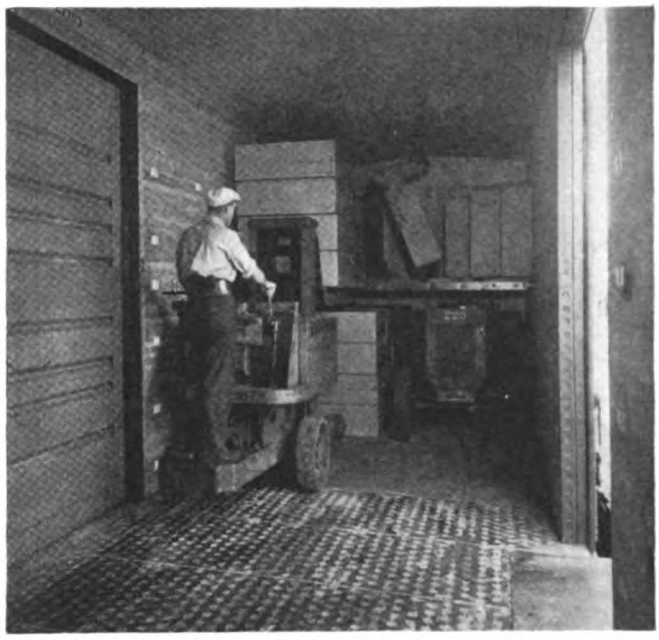
Cars for Double-Deck Loading

The combination double-deck anchoring device in 25 of the cars has been installed to meet the growing demand for a more flexible means of handling various commodities and mixed loads. Although attempts in this direction have been made by several railroads it appears that the developments were such that the various cars became specialized units, adaptable only to certain types of lading. In addition to the double-deck feature, means are available for anchoring lading without nailing wooden braces to the sides or floor of the car.

The principal new features of these 25 cars include the application of 144 metal anchor pockets to the interior side walls, which can be used for anchorage of cross beams when double- or even triple-deck loading is used. These pockets are located at six elevations and at 12 intervals on either side of the inside walls of the car. When the supports are in place across the inside of the car, grain doors or other flooring is laid thereon to provide a second or third deck, as needed. These are held in place by nails through the wood centers of the steel cross beams. When the cross beams are not in use, they are carried in a receptacle underneath the car, and to protect them from being stolen a seal pin and seal is applied. The anchor pockets, which have a flat upright key pin welded in each pocket, can also be used to hold



Hydromatic spot-welding machine used in Milwaukee, Wis., shops to fabricate the car sides at the C. M. St. P. & P.

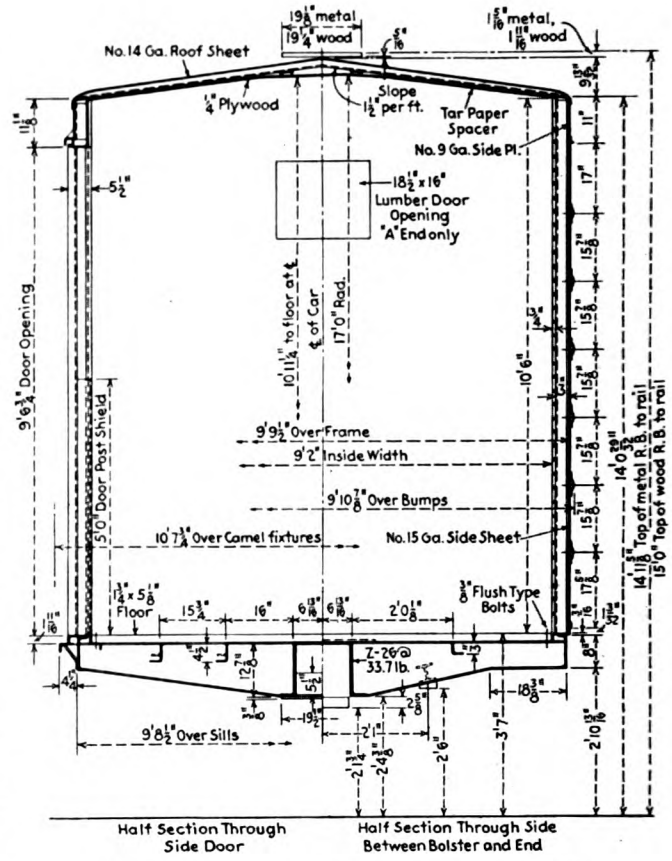


Special steel floor plates can be seen at the doorway—The lift truck is used in applying double-deck load

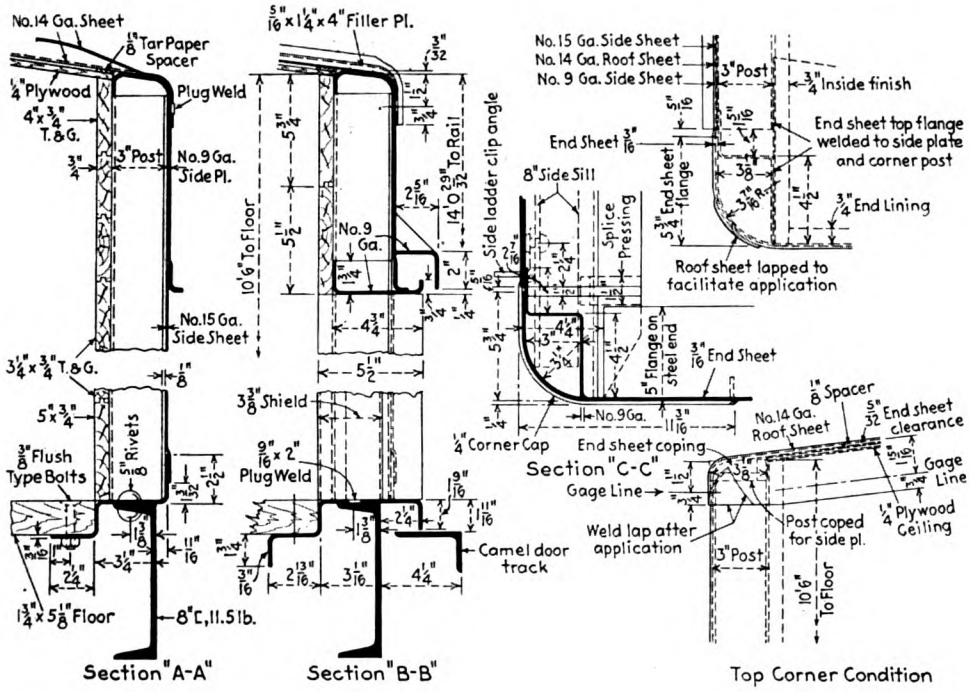
flexible steel straps. When drawn taut with a mechanical ratchet device these straps prevent shifting of the lading, and eliminate the wooden cleats or blocking now generally used. The straps may also be used instead of lumber as door protection. The design of the metal pockets provides a flush interior and does not interfere with present standard loading methods for bulk or package commodities.

This double-deck loading design lends itself more readily to split or mixed l. c. l. loads and the loading of like commodities when high piling might crush the lower tiers; and cost and time are saved in anchoring the load due to the use of the metal banding. Where the rates for tractor loadings for eastern and southern territories are the same regardless of the size of car used or the weight of load therein, it has been demonstrated that by double decking the loads, the 40-ft. car will carry an ordinary 50-ft. car load. Therefore, as the lighter 40-ft. car is less costly to build and maintain, it should prove more adaptable to general transportation requirements.

The method of anchoring the loads with metal straps also tends to prevent damage to both the floor and the side lining, which constitute the most important single elements of car-repair cost. The new construction therefore is well adapted to make a substantial reduction in car maintenance expense. The principal objective, however, is to provide improved service and hence attract new business to the rails.



Half-sections through a Milwaukee 50-ton box car



Roof and corner sections of a Milwaukee 50-ton box car

Factors Influencing the

Service of Firebox Materials*

By Ray McBrian †

Aging properties, surface strength and the effect of temperature considered — Use of alloying elements, particularly molybdenum, to improve characteristics of firebox materials discussed

We have been challenged to seek improvements in the steam locomotive or to face the possibility of seeing it replaced by other types of motive power. I hope, by this paper, to point out some difficulties encountered and outline possible improvements which may be made in our present type of firebox materials.

The important factors which have not been fully understood, or readily recognized, as affecting the service life of firebox materials may be classed as follows: (1) Effect of temperature, (2) surface strength and (3) aging properties. These will be discussed in detail, but may I first suggest a comparison between the effects of service upon firebox materials and the effects of time upon ourselves. Similarly, as we age with the passing years and develop such weaknesses as stiffening of the joints, hardening of the arteries, etc., so do our firebox materials react to the effects of service environment. A good many of you, who are beginning to work with higher boiler pressures, are possibly having troubles which you did not experience before and are aware that these problems do arise from service.

Since you are familiar with constructional and design problems, this paper will be confined to a discussion of the problems relating to the materials used in the firebox which is subjected to the severest operating conditions.

Effect of Temperature on Firebox Materials

All of us recall that our specifications for firebox, boiler, and staybolt materials are based upon the properties of the material, determined by tests made at room temperature. We also know that the severest service imposed on these materials occurs at elevated temperatures. Many of you realize, I am sure, that the properties of these materials at service temperatures differ greatly from those properties we determined at room temperature, and that we should have based our specifications upon actual operating temperatures. To demonstrate, Fig. 1 shows the physical properties of A. A. R. plain carbon rimmed steel. It will be noted that the physical properties change with an increase in temperature. At 400 deg. F., for instance, the tensile or ultimate strength is almost double the room-temperature value,

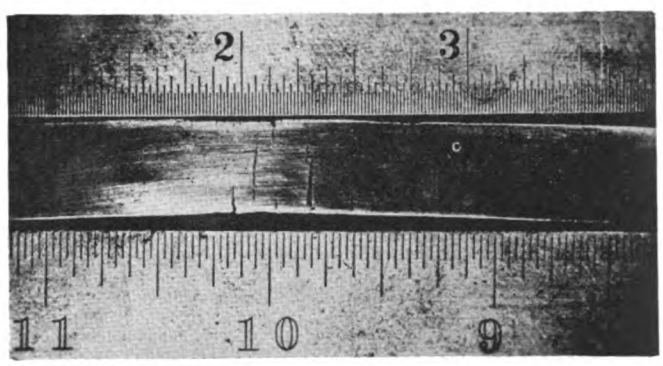
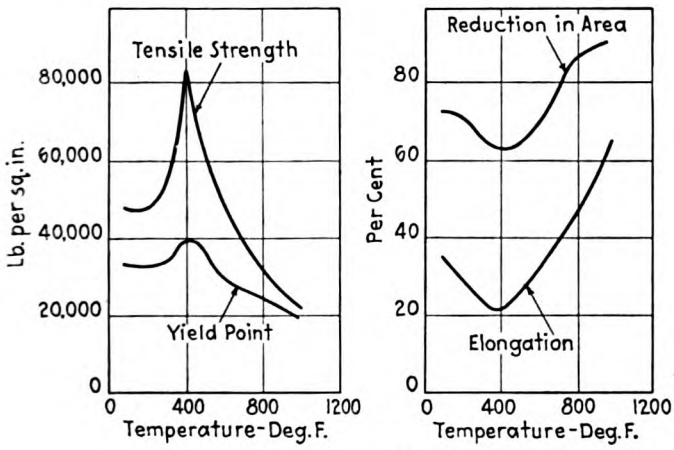


Fig. 2—This piece of firebox steel met room-temperature specifications when applied. In service it has been deformed permanently.

and, at 1,000 deg. F., it is practically half the room-temperature value. Similarly, there are changes in the values for the yield point, elongation and reduction of area.

Let us examine, for a moment, the temperature range 300-600 deg. F. These temperatures are commonly associated with the "blue brittle" range. This brittling phenomenon is also observed in the case of firebox steel, which, at 400 deg. F., has a marked elevation of tensile strength and yield point, coincident with a lowering of the elongation and reduction of area. Compared with the room temperature values, these properties at 400 deg. F., indicate brittleness. Because of its importance, I call attention to the peaks shown on this diagram. These peaks, which show a sharp rise in tensile strength, do not necessarily mean that because the tensile strength is higher the steel is better, but, on the contrary, they indicate a very pronounced aging tendency.

This discussion may seem somewhat technical, but let us examine its effect from the practical standpoint. In other words, let us translate this diagram into practical terms. Fig. 2 shows a piece of firebox steel which passed the room-temperature specifications, yet in service we



Chemical Composition

Carbon, per cent	0.11
Manganese, per cent	0.41
Phosphorus, per cent	0.010
Sulphur, per cent	0.028
Silica, per cent	0.008

Fig. 1—Change of physical properties of a typical rimmed steel with an increase in temperature.

* Paper presented at a session of the Master Boiler Makers' Association annual meeting, October 23, 1940, at the Hotel Sherman, Chicago. The data collected and the conclusions presented in this paper have been the result of a co-operative research program of the National Aluminate Corporation and the Denver & Rio Grande Western.

† Engineer of tests, Denver & Rio Grande Western.

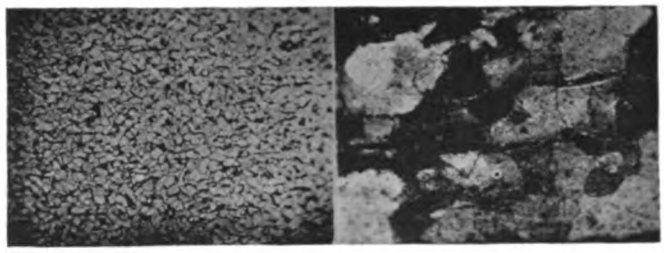


Fig. 3—Left: Normal structure of A. A. R. firebox-grade low-carbon steel. Right: Grain growth and incipient fusion at grain boundaries of burned firebox steel. (Magnification: Left, 100; Right, 250.)

see that the plate has been permanently deformed. This deformation can occur in only one way. The elastic limit must have been exceeded; not the elastic limit at room temperature, but the elastic limit the steel possessed when it was deformed. For example, as shown in Fig. 1, at 1,000 deg. F., the stress necessary to produce such a deformation may be only half the value necessary at room temperature.

The question naturally arises as to the effect of some insulating medium such as scale in raising the temperature, but I would like to stress the need of recognizing the actual operating temperatures, as we have had the opportunity to examine permanent deformations or corrugations which occurred very soon after the locomotive was built and put into service. Examination of these corrugated sheets failed to reveal any cause for deformation other than stress-temperature conditions prevailing in

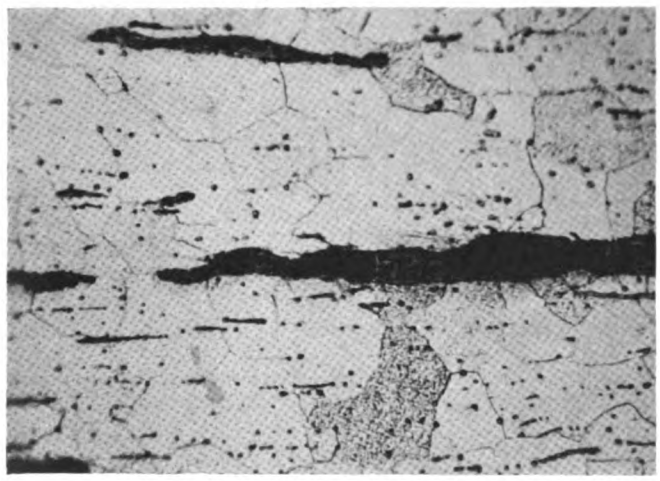


Fig. 4—Typical structure of a wrought iron staybolt. (Magnification of micrograph, 250.)

service. Elevated temperature tests also revealed that the material had too low an elastic limit at the operating temperature.

Many times the question has arisen as to whether or not a piece of firebox steel has been burned. Fig. 3 may be of interest to you in that it shows how this condition may be detected and recognized. The micrograph at the left shows the structure of normal low-carbon steel (A.A.R. firebox grade) while the one at the right shows the tremendous grain growth and incipient fusion at the grain boundaries associated with the burning of the same type of material.

We have observed the effect of temperatures as high as 1,000 deg. F. in the head of an iron staybolt. To illustrate, Fig. 4 shows the typical structure of a wrought-iron staybolt. Fig. 5 shows the microstructure of an iron staybolt that had been in service for some years. The coarse grains of this structure were reproduced by recrystallization after cold work. Since the lowest temperature of recrystallization is around 1,000 deg. F., we know that the head of this staybolt had been subjected to this temperature; otherwise, the iron would not have recrystallized. This is of importance because it shows that some of our materials of construction have high surface temperatures. These temperatures vary throughout the material and result in temperature-stress gradients.

Since we have mentioned iron staybolts, the question

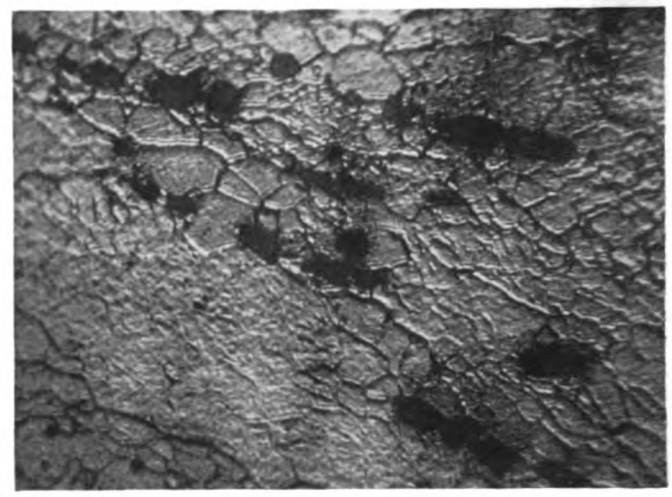


Fig. 5—Microstructure of an iron staybolt after some years of service. (Magnification, 1,000.)

probably arises, do the changes in physical properties at elevated temperatures apply to iron as well as to low-carbon steel. Fig. 6 shows the effect of temperature on the physical properties of double refined staybolt iron. It is of importance to note the changes in the physical properties at 400 deg. F., where there is an increase in tensile strength and a decrease in ductility. Also note the low tensile properties at 1,000 deg. F. We have made tests on a large number of the standard staybolt irons and have one instance on record where, at 1,000 deg. F., the staybolt had practically no tensile strength. The effect of the use of such materials, with their very low physical properties at operating temperatures, is the occurrence of such service failures as pulled bolts and possibly leaks.

Surface Strength

I am reminded of an old axiom, a chain is as strong as its weakest link. The center of a steel plate is the link

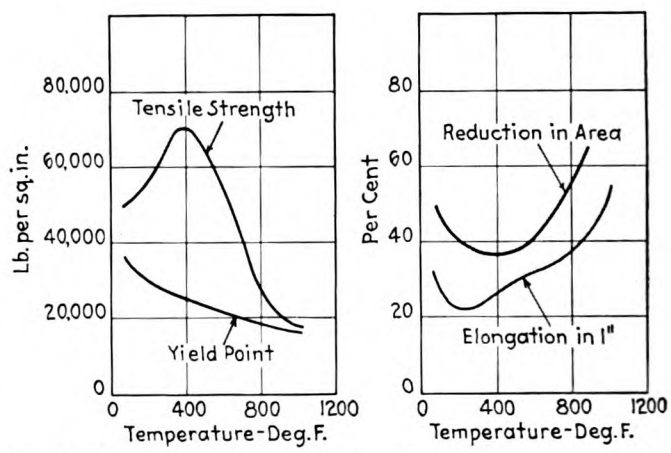


Fig. 6—Effect of temperature on the physical properties of double refined staybolt iron.

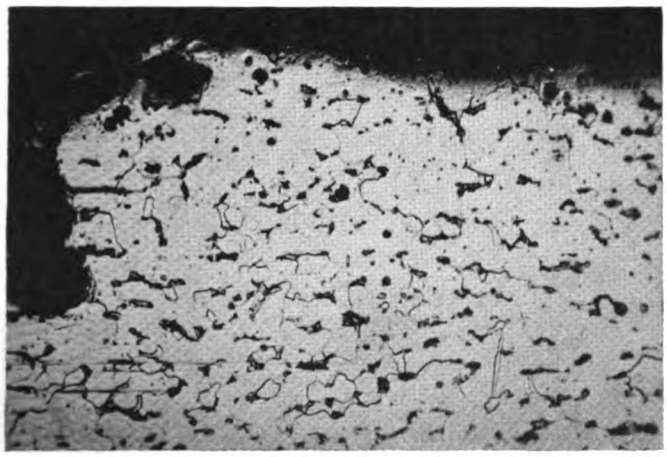


Fig. 7—Photomicrograph at the surface of a section of A. A. R. firebox steel. A depletion of the carbon at the surface is indicated by the decrease in dark areas at the top. (Magnification, 100.)

which connects the two surfaces, and, if the surface of the plate were as strong as the center, we would have a strong chain from edge to edge. But, unfortunately for us, this is not the case. All constructional steels fabricated in the hot rolled condition have decarburized surfaces. This decarburized surface, as you may know, is produced by the oxidation and diffusion of carbon out of the steel at its surface and may vary from a few thousandths to somewhat over one-hundredth of an inch. Obviously, the strength of the plate is less at the surface than at the center. Yet we have failed to recognize and take into consideration this condition. Fig. 7 is a photomicrograph at the surface of a section of standard A.A.R. firebox steel, showing a depletion of carbon at the surface, as shown by the decrease in the number of the dark areas which contain the carbon, and an increase in the light or ferritic areas. Although the average physical properties of the cross section may be within the specification requirements, as measured by the tensile test, it is to be noted that the decarburized layer at the surface may have only one-half the strength of the interior. Remember, also, that the physical properties for both the interior and surface change with temperature, and it is at the surface where the highest temperature is obtained that maximum stresses can occur. It is also at the surface where fatigue cracks originate and, as an example of what may occur in service, Figs. 8, 9 and 10 show surface fatigue cracks which occurred because of insufficient surface strength. This material, as purchased, met the A.A.R. specifications, yet failed after only eight months of service. Fig. 8 shows the fire-side surface of the plate, as received for examination. Fig. 9 shows this same surface after having been Magnafluxed. You will note the outline by the Magnaflux powder of the fatigue cracks. Fig. 10 shows this same surface after a portion of it had been ground. It is noted that, even after grinding the cracks prevail, showing that they had progressed to considerable depth.

Steel staybolts are subject to surface weakness, due to surface decarburization, which may be the cause of failure, as shown in the next two illustrations. Fig. 11 is a photomicrograph, showing decarburization at the surface and a small crack. Fig. 12 shows a section of the failed bolt. It is important to call attention to the fact that steel staybolts may be subjected to aging.

Service Aging

Aging is a spontaneous change of physical properties with the passage of time. This change is accelerated by the application of stress and an increase in temperature, and manifests itself in boiler and firebox steels by a raising of the yield and ultimate strength, accompanied by a corresponding loss in ductility. In the case of firebox and boiler steel, this aging is accelerated by cyclic stresses.

A stress cycle occurs each time the locomotive is fired up. Washing, and repeated heatings and coolings occasioned by feed water intermittently passing over the hot metal, introduce stresses, as do the opening and closing of the throttle while the engine is working. Table 1 shows the effect of boiler washing on the aging of firebox steel, which is shown by an increase in the yield point. It will

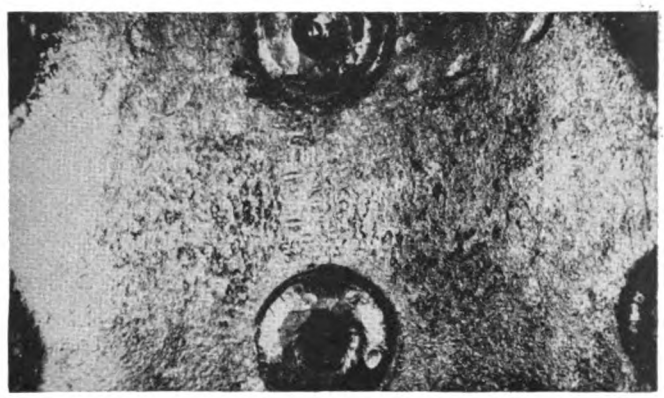


Fig. 8—Fire-side surface of a piece of firebox plate that developed fatigue cracks because of insufficient surface strength.

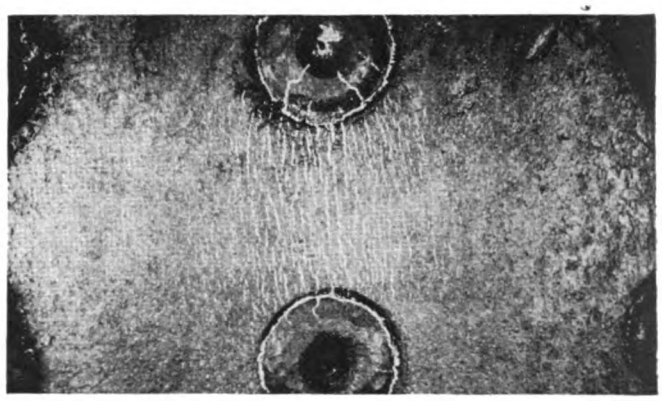


Fig. 9—The same surface shown in Fig. 8 after having been Magnafluxed. This plate failed after only eight months of service.

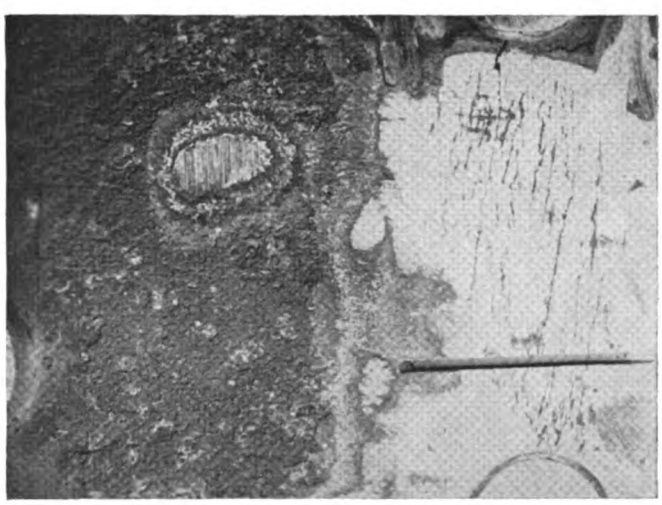


Fig. 10—The surface shown in Figs. 8 and 9 after a portion of it had been ground showing the cracks had progressed to a considerable depth.

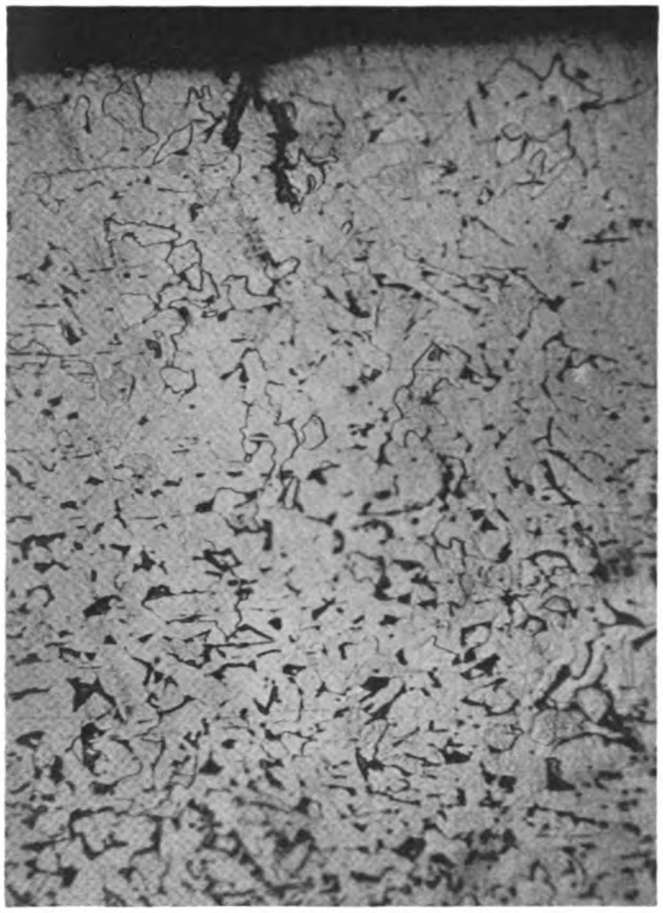


Fig. 11—Photomicrograph showing surface decarburization and a small crack in the surface of a steel staybolt that failed. (Magnification, 100)

be noted that the least aging occurred on sheets in locomotives operating on a 30-day washout schedule.

The effect of aging has also been investigated by the application of X-Ray diffraction. In this method, the amount of strain is determined from the atomic displacement in the lattice. An example of this method of checking aging, Fig. 13, shows the diffraction of a piece of firebox steel which has not been aged. The diffraction patterns were made on the surface of the fire side, the center of the material, and the surface of the water side. This material, when removed from service, had a yield point of 35,000 lb. per sq. in. The three bottom photographs are patterns of a severely aged specimen which had a yield point of 49,360 lbs. per sq. in. and an ultimate strength of 59,150 lbs. per sq. in. Without going into details, I have shown this as a new method of analysis. It will be noted that the material is not strained or aged uniformly from surface to center.

Table II gives the results of physical tests of some firebox plate removed from service on an eastern locomotive. This was rimmed steel and, as shown in Fig. 1, rimmed steel has elevated temperature characteristics of very pronounced peaks in the blue-brittle range. The peaks indicate that this type of material would age, and, from this service test, it can be seen that aging had been severe.

Fig. 14 will be of interest in that it shows a specimen cut from a crown sheet which had aged in service. It will be seen that the specimen exhibits a double necking phenomenon. These necks occurred adjacent to staybolts. In connection with the aging problem, there are, of course, other influences which should be briefly mentioned. One is the effect of the design which permits stresses to be localized. Another is the effect of the plac-

Table I—Effect of Boiler Washing on the Aging of Firebox Steel

Location	Years of service	Yield point, lb. per sq. in.	Ultimate strength, lb. per sq. in.
Average of 30 days between boiler washouts.			
Side sheet	15	34,100	61,700
Side sheet	7	35,100	61,900
Crown sheet	20	44,100	59,620
Back head	17	42,970	66,800
Door sheet	16	38,920	55,620
Crown sheet	16	48,870	64,120
Side sheet	16	43,280	59,200
Side sheet	16	43,400	60,980
Average of 15 to 20 days between boiler washouts.			
Door sheet	6	41,300	60,250
Side sheet	7	35,100	61,900
Side sheet	12	46,600	61,000
Crown sheet	21	41,200	55,750
Side sheet	19	48,400	65,200
Side sheet	16	45,450	66,900
Average of 2 to 5 days between boiler washouts.			
Door sheet	11	51,400	57,620
Side sheet	10	47,100	61,000
Crown sheet	9	48,200	58,840
Crown sheet	9	55,900	68,340
Side sheet	10	51,390	57,180
Side sheet	10	51,250	60,000

Table II—Physical Tests, Firebox Plate

	As rolled	As removed from service
Yield point, lb. per sq. in.	36,000	60,200
Ultimate, lb. per sq. in.	57,400	66,200
Elongation, per cent	33.0	25.0
Reduction of area, per cent	61.0	56.5

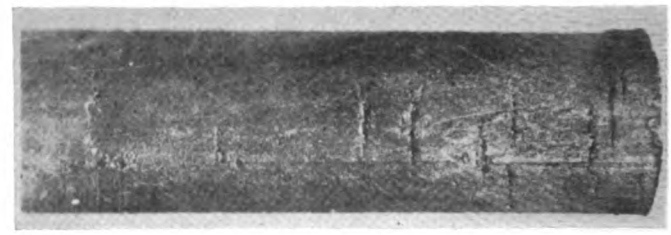


Fig. 12—A section of the steel staybolt, the surface of which is shown in Fig. 11.

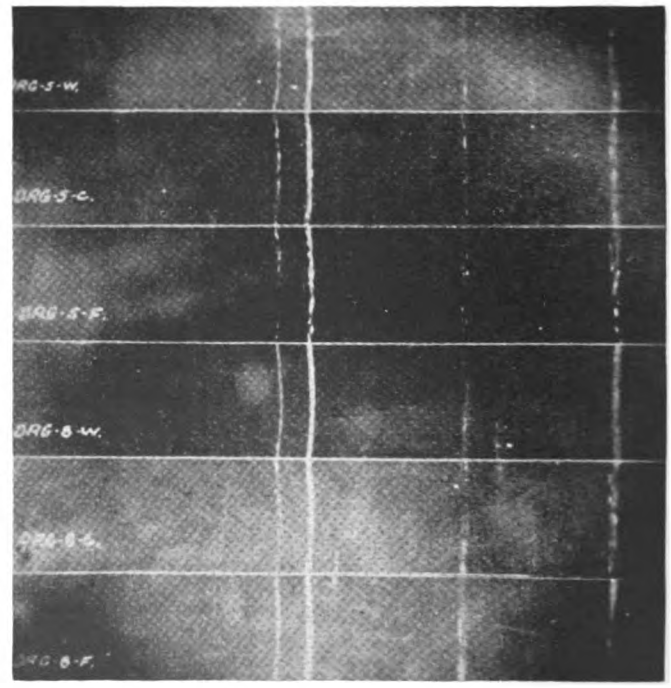


Fig. 13—Diffraction patterns made on the fire-side surface, center and water-side surface of a piece of firebox steel. The top three patterns are of a specimen that has not been aged, the bottom three are of one severely aged.

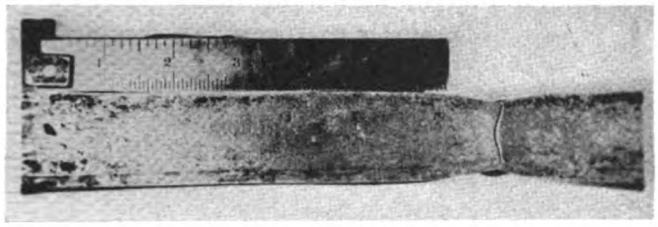


Fig. 14—This specimen cut from a crown sheet, aged in service, exhibits a double-necking phenomenon.

ing of low-carbon and high-carbon sheets in the same firebox. By low and high carbon, I mean carbon in the lower range and higher range of our present specification. An actual example is one where we found that, where a 20 carbon material was used in the crown sheet, and a 14 carbon in the side sheet, the crown sheet aged in service. This, of course, suggests a question for consideration, and that is, do we permit too wide a carbon range in our specifications?

Molybdenum Improves Physical Properties

We have discussed three important factors which affect the service life of our firebox material. Now let us consider the possible approaches toward a solution of the problem. Of course, the obvious solution would be to provide a non-aging, uniform material, the strength of which under all operating conditions would be greater than the maximum stress that would be imposed upon it. This is rather a simplified expression, but probably the reason such a material has not yet been provided is because of the failure to recognize the full importance of these factors which have been under discussion.

Considering the elevated temperature effect, it will be necessary to select a material which not only has sufficient strength at elevated temperatures, but also one with physical properties as uniform as possible over the range of temperature occurring in service. Some satisfactory indications have been obtained from research studies by using alloy steels and from the making of alloy wrought iron. For example, a comparison of Figs. 15 and 16 will show the effect of the addition of molybdenum. Fig. 15 gives the physical properties of standard firebox steel. Fig. 16 gives the properties of a carbon-molybdenum steel. The addition of molybdenum has increased very materially the yield strength as well as the ultimate strength. Also, the ductility is greater for the molybdenum steel. This is one example of the benefits that may be obtained by the addition of alloying elements.

Molybdenum has also been added to staybolt iron to make an alloy, and Fig. 17 gives the physical properties of this material at elevated temperatures. Comparing this with the properties of the standard staybolt iron which are shown in Fig. 6, it will be noted that the properties at elevated temperatures have been improved. Of special importance is the maintaining of higher yield strengths at the higher temperatures in this alloy iron.

Our designers and writers of specifications should take into consideration the physical properties at elevated temperatures of the materials to be used. Probably alloy steels and alloy irons will be a necessary requirement. The use of an alloying element such as molybdenum in both iron and steel will thus aid in preventing deformations occurring from lack of physical strength under operating conditions. It will aid in preventing leaks at the higher pressures and temperatures by allowing a material to be used which has greater yield strengths and which is capable of maintaining loads at larger elastic strains.

Considering now the factor of surface strength, it has been shown that the rolled surface may be seriously weakened by the presence of a decarburized layer. Present manufacturing methods, however, seem to offer little promise for the elimination of this decarburization, but, until we are able to purchase steel free of decarburization we must look for some other means to eliminate surface weakness. If it is not practical to remove it, what can be done to strengthen it? Again we find the use of alloys suggested, and molybdenum again is beneficial. This element enters into a solution with the iron or ferritic surface and gives it added strength. Although the carbon may be depleted from the surface of a molybde-

(Continued on page 540)

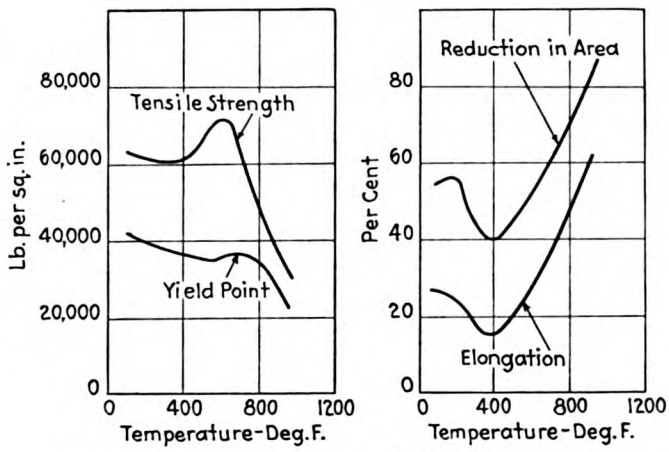


Fig. 15—Physical properties of standard firebox steel.

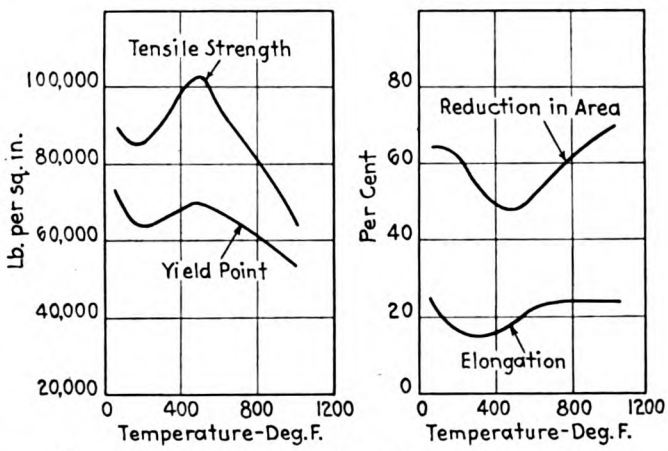


Fig. 16—Physical properties of a carbon-molybdenum steel.

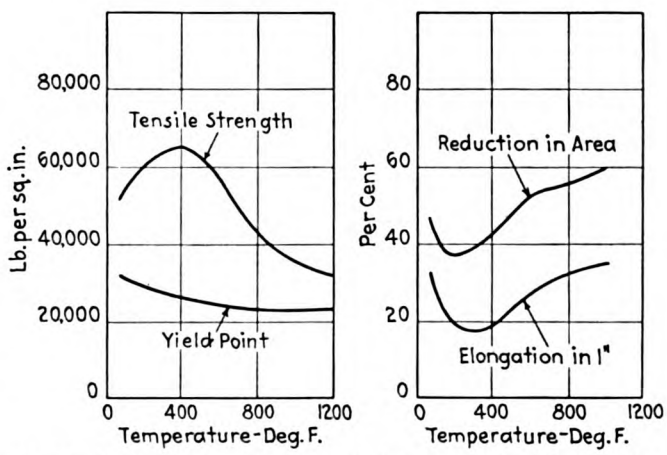


Fig. 17—Physical properties of staybolt iron to which molybdenum has been added. Compare with physical properties shown in Fig. 6.

Two Jobs

For Every Railroad Man*



Col. R. S. Henry

By Robert S. Henry†

Weak spot in railroad case is that public (your neighbors) does not understand the real facts

We in the railroad business get lectured quite a bit from various sources, to the effect that we should learn how to co-ordinate. There is a thought in some quarters, at least, that railroad men are by nature so rabidly individualistic that they can't get together to accomplish a common end. Yet to anyone who really knows what to look at, the railroad business offers the greatest demonstration known in the business world of effective, everyday, all-inclusive working co-ordination of effort.

The most remarkable fact about commerce on this North American continent is the fact that any one anywhere can pick up a telephone and ask for a freight car to be placed at his dock or track for loading, that he can load that car to go anywhere else on this continent, or even to Cuba, and turn it over to a railroad, and never think about it again until, in due course, it is delivered at the other end. Nowhere else on earth, and in no other business in the United States, is there such a high degree of practical, everyday operating co-ordination as is demonstrated by this simple fact which has existed so long that all take it for granted, and think no more about it.

I sometimes wonder if that isn't one of our difficulties in the railroad business. We, ourselves—as well as the people whom we serve, and whose lives depend upon our service—have come to take our service too much for granted. We have ceased to recognize the enormous number of skills that are required to do these things. We have ceased to recognize the high degree of managerial adjustment, the high degree of co-ordinating ability that it requires to have something more than a million men in the three great nations which occupy this North American continent, all working to do the seemingly simple but actually very complex job of taking a carload of freight from anywhere on this continent to anywhere else, and doing it every day in the year, doing it regardless of mountains, regardless of rivers, regardless of snow or ice, regardless of heat or drought, doing it all seasons and in all weathers, and doing it so cheaply that the average revenue for hauling a ton of freight a mile on the railroads of North America is only a little less than one cent.

Perhaps we haven't impressed upon the public enough the tremendous job that the railroads and railroad men are doing for the rest of the people of this continent every day in the year.

Every Railroad Man Has Two Jobs!

There are somewhat more than a million railroad men in North America. Every one of them has two jobs, whether he knows it or not. He has the job that he was specifically hired to do, some one of the 128 major classifications of jobs, according to the Interstate Commerce Commission and in addition to his regular job, he has another. *He is an ambassador, a representative of his industry to the public whom we serve, the public upon whose support and patronage we depend and by which we exist.*

Every railroad man is a public relations man, whether he knows it or not. He may be, as most of them are, a good public relations man, or he may be, as some few of them unhappily are, a bad public relations man, but a public relations man of some sort he is. Everything he does every day, in the carrying out of his duties and in his dealings with the public, and in his personal contacts when off duty, with his friends and neighbors, everything he does every day affects the regard, the esteem, the understanding, the appreciation that the people of this continent have for the railroad industry. It affects not only what they think about us, but what is far more important, how they feel about us.

For some curious reason the people of the United States look upon the railroads not as separate companies doing separate jobs. *They look on us as some sort of an entity*—"the railroads"—and they either like us or don't like us. So a second part of every railroad man's job, in addition to the specific duties he is hired to perform, is *the way he does his other duty, the way he acquits his other responsibility of being an ambassador to the public.*

It is up to us to know the story of railroads, to know what they are, to know what they do, to know what they mean in this country. It is up to us not only to know the story, but to tell it, because upon public understanding

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* Address at the joint opening session of the annual meetings of the Railway Fuel and Traveling Engineers' Association, Car Department Officers' Association, Master Boiler Makers' Association and Locomotive Maintenance Officers' Association, held at Chicago, October 22, 1940.

† Assistant to the president, Association of American Railroads.

and public appreciation of the facts about railroad transportation depends, in the long run, not only the financial success or failure of the companies for which we work, but also the payroll, the pay envelope, the pay check of every man who works for the railroads.

The Railroad Story

Now what is this railroad story that we need to know and tell? I hardly need to go over it in any detail, but I do want to hit one or two of the highlights, one or two of the things common to all railroads in the United States.

There is one thing that everybody knows about—for the last ten years, at least, we haven't made as much money as we should have made to keep our credit good and to maintain our ability to continue to make improvements up to the level that we would like to have. Thirty-one per cent of the railroad mileage of the United States is in the hands of the courts in one form of bankruptcy or another, and there is a school of thought in this country (happily declining in importance and influence, I think) which believes that the cure for the so-called railroad problem is—but let me go back a bit.

We talk about the railroad problem now. There has always been a railroad problem. *A little more than a hundred years ago, the problem was whether you could get trains to run on tracks or not.* That was solved. *The next problem was to get railroads in this country.* The country had to have them; the country was crying for them; people everywhere demanded railroads. The problem was to find the money. In a few decades this country was spanned with a network of rails, and that problem was solved.

Our next problem was to increase the operating efficiency and improve the service of the railroads. We had to make better roads, more efficient roads, roads which could produce more service at lower cost, roads which could sell their services for less and pay their men more.

Sixty or seventy years ago, the average revenue for hauling a ton of freight one mile was more than 3 cents. In those days, $2 a day represented good wages. Most railroad men worked for a dollar a day or thereabouts, and many of them worked for less than that. You could hardly find taxes, as compared with present taxes.

Now we haul a ton of freight a mile for 1 cent—a little less than one-third of what we received for doing the same job sixty or seventy years ago. Wages have vastly improved, as they should have. Taxes have multiplied, as they have to do, and yet somehow we are doing the job for 1 cent and meeting these other costs as they come along.

That didn't just happen. We are not better railroad men than the men back in those days were, individually, man for man. The difference lies in the tools we work with, the plant we use, the investment which has been made to make it possible to do the job better and more cheaply. Because we have got the kind of railroads we have now, we are able to do the things we do now.

So that railroad problem was solved. Not perfectly. The solution still goes on. I hope we never have to stop doing the job better with better tools and better methods.

The Earnings Problem Not Solved

But there is one railroad problem we have not yet been able to solve, and that is the earnings problem. For the last 20 years—since the World War—this country has seen a great boom and a great depression. When the boom was on, the theory of those who controlled public policy dealing with railroads was that railroads, forming a regulated industry, should not be allowed to make too much money.

Our prices didn't go up in the boom. We didn't enjoy the boom period as others enjoyed it. We ran along pretty well on an even keel, devoting a large part of our earnings in that period to the necessary rehabilitation and improvement of the railroads made necessary by the results and experiences of the World War. Those were the years in which we modernized these railroads, but we didn't let people know about it.

There is nothing much more modern than our railroads now. I don't mean that everything about them is modern, of course, but the big modernizing job, the fundamental job—the capacity we have built into our tracks, terminals, bridges and signals, improvements in our power and cars—is pretty well carried forward, so that it cannot be said that our present financial difficulties are due to any deterioration of service. Service today is far better than it was in the years when railroads were more prosperous. Our trains are running faster; they are producing more ton-miles per train-hour. They are doing the work more efficiently, far more dependably than they were at the close of the World War and the years just after that.

It cannot be said that our difficulties of this period are due to raising our rates so high that we have discouraged our business, because our rates, on the whole, have been declining since the years when we were more prosperous. Our passenger rates today are the lowest they have been in the history of railroading. Our freight rates are approximately one-fourth less than they were just at the close of the World War period.

Fallacy of "Wringer" Prescription

Neither can be it said that our difficulties are due to an increase in the burden of capitalization or debt—even though one of the popular prescriptions for curing whatever is wrong with the railroads is the so-called "put them through the wringer" prescription.

The thing we shall put through the wringer, if we adopt the "wringer" prescription, is the hopes and just expectations of the people who put up their money and savings to build and improve these railroads. Our investors are not big, rich people. There is not much "rich" money in the railroad business—it is small investors' money, life insurance money, savings bank money. We have nearly a million bondholders, 65,000,000 life insurance policyholders, 30,000,000 savings bank depositors, and nearly a million stockholders interested in railroads. They are small holdings on the whole. These people have put up much of their money on securities the issuance of which was approved by public authority. They put it up with the fair expectation and the just right to receive a return on it, if we could earn it. In many cases we haven't been able to earn it. That is the real problem of the railroad business, not the physical problems. Those have been measurably well solved, and the solution is improving from day to day and from year to year. The big problem is how we are going to earn what these people are entitled to, these people who provide the tools with which we work, and *that* problem is not going to be solved by a wholesale, unnecessary repudiation of our obligations.

There are times when any business may have to go through the wringer, and there are processes provided for that sort of thing—processes of bankruptcy in the courts—and I might say right here that railroads, although 31 per cent of the mileage is in one form or another of bankruptcy, have no monopoly on going broke. Others go broke too, and machinery is provided by the law to meet such situations when they arise.

But to force railroads as a class to reduce their capital obligations unnecessarily, is simply deferred confiscation of the money that people—just ordinary people like us—put into them.

Capitalization Not Excessive

Excessive capitalization is not the cause of railroad financial difficulties. Thirty years ago, when railroads were relatively prosperous, the total capitalization for each $1000 invested in railroad plants and equipment amounted to $987. That is, all the stocks, bonds, equipment trust certificates and every other form of outstanding capital obligation amounted to $987 out of each $1000 invested. Last year the total capitalization of the railroads amounted to $715 for each $1000 invested. All the stocks, all bonds, all equipment trust certificates, all of everything else, amounted to only $715 for each $1000 invested.

Thirty years ago our debt on bonds amounted to $606 for each $1000 invested. We were in the position then of a man with a house in which he had invested $10,000, and on which he had a mortgage for $6060. Last year our bonds amounted to $420 per thousand dollars invested. We are now in the position of a man with a house in which he had invested $10,000, and on which he had a mortgage of $4200.

During the years in which our relative prosperity (as compared to the rest of the country) has declined, our burden of debt has been growing smaller, so that whatever may be the cause of our trouble, it certainly isn't growing debt.

But it is perfectly obvious that there is some cause of railroad financial disability. What is it? It lies in one fact—the public policies applied to transportation in this country throughout the past generation or two. Notice I said "policies," because we have two, and they are just as distinct as they can be. They are perfectly contradictory, or have been up until the very recent past.

To the railroads public policies say "You shall be self-supporting. You shall provide your own ways, your own tools and equipment, your own investment of all sorts. Then having done that, you shall pay all your own expenses. In addition to that, you shall pay taxes, real taxes, not money earmarked to be spent on railroad tracks but money that goes to keep up schools and public institutions in the general operations of government."

Taxes and Subsidized Competition

The taxes of the railroad industry are a very serious item. I don't mean to say that we are overtaxed, as compared with other industries. I don't know—you could get up an argument about that, I presume—but it is a fact that whereas 30 years ago we were paying about 2 or 3 cents out of each dollar of revenue for taxes, last year we paid just under 10 cents on each dollar of revenue received for taxes.

Taxes, you know, come out first. With that position we can have no proper quarrel. Every business ought to be self-supporting, if it is economically justified. Every business ought to help support government. Somebody has to support it, and in the long run, the earnings to support government have got to come out of business.

But when we come to most of the other kinds of transportation in this country, we reverse that practice and the money comes out of the government to help support transportation. That makes a difference. I shall not go into it at great length here, but let me take one example —the waterways. We talk about "cheap water transportation" in this country. In fact, we have talked about it so much that we have run the three words all together —"cheapwaterwaytransportation"—as if it were all one word.

Now there *is* cheap water transportation, and there is water transportation so fantastically expensive that only a rich and prodigal government like that of the United States could dream of providing and supporting it. I'm not going to take the horrible examples; let's take the best. Let's take the Ohio river, the best of the long distance inland improved river transportation systems in the United States.

The Ohio river isn't a natural stream. For commercial purposes we have had to build a river, and it has cost us a lot of money. I am not going to give you the gross figures, because gross figures don't do me or anyone any good. We have all become so used to thinking in terms of billions and hundreds of millions that the sound has ceased to affect us. In fact, there is a certain large, mouth-filling, soul-satisfying sound about a hundred million dollars. (Laughter.)

So let's not take these hundreds of millions and talk about them; let us cut them down to size. To build the Ohio river has cost the taxpayers of the United States $143,000 a mile. That mile is measured not on any straight-line distance or short line rail distance, but as the river winds. To convert that into equivalent rail miles, add about a third. So to build that river—and that is what we have done, built a river—has cost a little more than $200,000 a mile.

Now by way of comparison, look at the railroads. The railroad lines—roadway and bridges alone—of the United States cost $62,000 a mile to build, so that your river is three and one-half times as expensive per mile to build as a railroad line. To maintain that river costs about $4800 a mile on the average, measured as the river winds. Reduce that to an equivalent rail distance, and you will add another $1500, and you get your total up over $6000 per mile, which again is about three and one-half times what it costs to maintain the average railroad mile in the United States.

That is what we mean when we talk about "cheap water transportation." Of course the difference lies in the fact that the taxpayers pay for the water transportation. The taxpayer, you know, is an amiable goat who is so used to paying that he hardly knows what he does pay for, anyhow.

A Word About Truck Transport

When you get over on the truck transport side, the truck people say they pay more than they should. A lot of studies have been made on that, by people representing the American Association of Railroads, people representing the Federal Co-ordinator of Transportation, the truck people, and others, but I have noticed this: In only three states have the responsible authorities made studies and announced their results. When I say "responsible authorities," I mean the men who are responsible for getting in the money, and spending it properly after they have it in; the men who have to raise so much revenue to keep up so many miles of highway under such and such traffic conditions.

The three states that have made such studies—Illinois, Missouri and Utah—all agree that heavy highway haulers are paying but a fraction what they should in order to insure adequate maintenance of highways. In some cases it was found they were paying as little as one-fourth of what they should pay to meet fully the cost which their heavy use of the roads imposes on all the rest of us.

So that is what we are up against in the railroad business. We are self-supporting, and we should be. We are taxpaying, and we should be. But by the same token, so should every other form of transportation stand on its own two feet, pay its own way, meet its own costs, and help support the general operations of government, public institutions and public education.

Under such conditions, the inherent advantages, the real economy, the actual cost of doing transportation by each of the various forms of transport would stand out, because we would all have to put our costs, whatever the costs were, in the rates, and not just part of it in the

rates and the rest of it on the taxpayer, to be paid by somebody else.

Step in Right Direction

A significant thing happened this year. Congress passed the Transportation Act of 1940. It is not a perfect act; it is not going to cure railroad troubles. It is not going to produce perfect equity and complete equality in our transportation world, but it is a step in the right direction.

One thing in that act is highly significant. For the first time in the history of transportation legislation, the Congress of the United States has said to the regulatory authorities which it has set up, in effect, that we, the Congress, expect you to treat all forms of transportation alike in your regulation of their activities.

How significant that is! Its full significance is only apparent when you look at the previous state of the law. The railroads were regulated. The air lines were regulated, too, but that regulation has been largely promotional, and not restrictive. The Interstate Commerce Commission was instructed by Congress in 1920 to foster, encourage and promote water transportation. It was directed by Congress in 1935 to foster, encourage and promote highway transportation. But not until this good year 1940 has Congress ever said to the Interstate Commerce Commission, in effect, that we expect you to see that railroads are equally treated with these other forms of transportation.

That is not going to put any big money in our pockets right away, but in the long run it will have its effect as an expression of the public will through congressional action. Sooner or later the time will come when these railroads will be treated equally under the law with other forms of transportation.

(Mr. Henry then pointed out that in spite of the depression the railroads are in better position to render service than they were ten years ago. He portrayed in dramatic fashion the limitation of the highway carriers, even with super-highways, to handle the vast transportation necessary in connection with the national defense program. He referred to an advertisement urging people to patronize the trucking companies as a contribution to the relief of unemployment; in it the statement was made that it takes ten times as many men to handle a ton of freight per mile on trucks as it does on railroad trains.

He pointed out, also, that the railroads did not break down in 1917, but that their inability to function was due to the fact that exceedingly poor judgment was used by government authorities in applying priorities. "There were times in the eastern part of the United States," he said, "when yards had 85 per cent of their cars bearing the red government priority tag, and nobody could tell the poor yardmaster which priority had priority over all the other priorities. . . . The railroads didn't break down in 1917 as transportation machines. They weren't used as transportation machines; they were used for storage purposes."—Editor.)

Military Transportation Section

That sort of thing [the 1917 congestions] is not going to happen again, for one thing, because of a better understanding between the railroad industry and the government. We have set up, as part of our car service, a military transportation section, with offices in the War Department. Its job is to find out what the Army and Navy want in the way of transportation, and to arrange for it. It had a great test in August of this year.

At the peak of the World War, we moved in one month an average of 20,000 troops a day. That was in July, 1918. In three days in August—the month before last—with nobody knowing it, and with no excitement except a little bit around the immediate areas where the troops were concentrated, we moved an average of nearly 40,000 troops a day—nearly twice the size of the biggest average daily movements during the World War. That is organization, performance, and we can do it again.

During several months of this year there has gone through the Port of New York substantially the same amount of export freight that went out in the peak year of the World War. This was done so smoothly this year and so quietly, so efficiently, that almost nobody knew of it.

Railroads Ready for Emergency

Here is a major element in defense, the mass transportation that ties the whole thing together—that enables us to produce automobiles, trucks, airplanes, guns, powder, shells and all the other things that may be needed in this country. We couldn't produce any of those things in quantity but for the dependable mass service of the railroads. It is a reassuring fact that this underlying fundamental element is ready. It is asking nothing of government, it is asking nothing of the public, it is asking only one thing—that so far as may be, and as soon as it can be done, we should be put upon the same footing under the law as every other form of transportation, and that we be treated as the others are treated. When we are, this last railroad problem we have—the problem of making a living—will be solved.

We may have another railroad problem if this isn't solved—the problem of a bankrupt, broken-down system of railroads, dumped upon the doorstep of Uncle Sam—but I am hopeful that the people of the United States will learn the facts and see the facts. And that is our job, the job of the railroad business—not just the job of a few of us in the railroad business but the job of all of us—to acquaint the public with the true facts about the railroads. So I come back to where I started. The job of every man in the railroad business is to help see to it that people understand and appreciate what these railroads are, and what they do, and what they mean, and what they need to do better. If all of us do that, we will get what we need—fair and equal treatment under the law with every other form of transportation business. (Applause.)

K. C. S.—L. & A. "Southern Belle"

(*Continued from page 525*)

have aluminum cast surfaces with non-skid feature. Cars are provided with complete rubber closures at the vestibules so as to give the smooth, continuous side effect desired for streamlining. Diaphragm faces are covered with carpet for sound deadening, and all contacting surfaces are insulated to prevent noise.

All interior finish, partitions, bulkheads, sliding or swinging doors, have been insulated or equipped with anti-squeak tapes to eliminate interior noise. Parcel racks, lighting fixtures and decorative molding are aluminum natural finish.

Trucks

Four-wheel trucks are used on all cars. The trucks are the single drop-equalizer, swing-motion type, with alloy-cast-steel frames of which the pedestals are cast integral. Both equalizer and bolster springs are helical coil design of alloy steel. Vertical motion is controlled by shock absorbers, and truck bolsters are restrained longitudinally by the rubber-cushioned bolster anchor

rods. Lateral sway is controlled by the stabilizer arrangement which replaces the conventional spring plank. A. S. F. roller-bearing wheel units are installed using SKF roller bearings. Clasp brakes are of the Simplex Unit-Cylinder type.

Sound-deadening materials are used at bolster springs, truck center plates and body side bearings to isolate truck noises completely from the car body. Sound-deadening materials are also used at moving parts of coupler and face-plate mechanism.

Locomotives

The Diesel-electric locomotives, with a rating of 2,000 hp. each, are capable of a top speed of 117 miles an hour, but are designed in general to cover fast schedules with low rather than the high maximum speeds. This performance is made possible by the ability of the locomotives to accelerate and decelerate quickly, maintain speed on grades, take curves fast with safety because of their low center of gravity, and because frequent changes of locomotives are not necessary nor are frequent stops made for fuel and water. The locomotives have high initial tractive force which promotes fast and smooth train starting.

Provisions for the comfort of the engine crew include deeply upholstered, adjustable seats, the one on the engineman's side being placed so that the control levers are readily accessible. Special acoustical treatment insulates the cab from engine-room and outside noises, making it possible for the engineman and fireman to converse without appreciably raising their voices—another feature contributing to safety because of the greater ease in exchanging signal observations.

A Vapor-Clarkson automatic oil-burning boiler in the rear of the locomotive supplies steam heat for both the locomotive and passenger cars. Each locomotive carries 1,100 gal. of train-heating boiler water and 1,200 gal. of fuel. With a full supply of fuel, boiler water and sand, the total weight of each locomotive is slightly less than 300,000 lb. It is 71 ft. long, 14 ft. above the rail and about 10 ft. wide.

Service of Firebox Materials

(*Continued from page 535*)

num steel plate, the molybdenum remains in the ferrite and the surface retains a greater strength that the steel plate without this material. Surface strength, then, may be improved by the selection of an alloy which enters into solution with and strengthens the decarburized layer, remembering, of course, that the alloying material used must be capable of giving the surface increased strength at elevated and operating temperatures.

The study of the third factor, aging, has not, as yet, been as fruitful as the first two factors. As you can see, this is a very complex problem, and its cause even now is not well understood. Its effects are easily measured and observed. We are now attempting to develop a means of measuring the capacity of a steel to age, and I may say that to date the results are very promising. When we are able accurately to evaluate steels according to their aging properties, we may determine more certainly the cause for this unusual phenomenon. Present knowledge seems to indicate that steels showing a marked susceptibility to peaks in the blue-brittle range, as shown in the graphs, are more susceptible to aging than those which are less affected in the blue-brittle range. We believe a steel will be developed to resist aging, as our research shows promise for such a material.

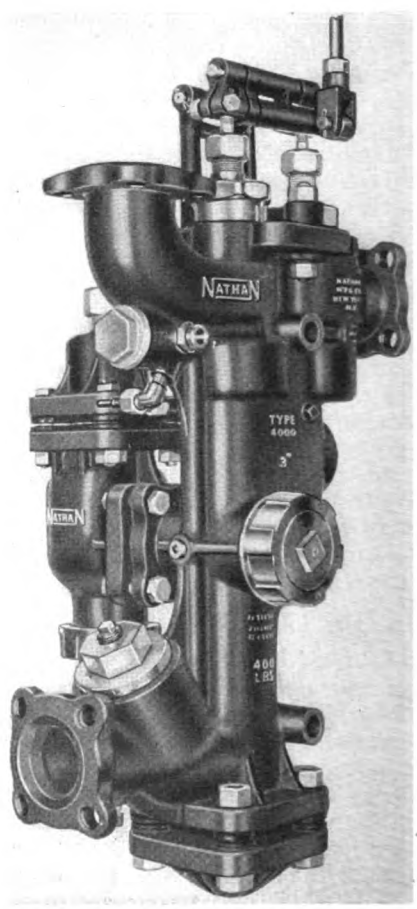
New Nathan Injector

A new type of injector has been introduced by the Nathan Manufacturing Company, New York, to supply a demand for an efficient boiler feed on high-capacity locomotives. This injector is equipped with an automatic restarting overflow which enables it to handle very hot tank water, permits a much finer regulation of the water supply than obtainable with a conventional injector and delivers the water to the boiler at higher temperatures. The outstanding advantage is that these improvements are obtained without sacrificing the restarting feature of the open-overflow type injector.

The injector will restart automatically even though the feedwater supply is interrupted momentarily. This is a new accomplishment in closed overflow operation and its value from a safety point of view is apparent. Especially at high speeds and with a low water level in the tank, surging of the water may cause the tank valve to become uncovered, causing the injector to break. Under these conditions the overflow is opened automatically, a steam blow-back into the tank is prevented, and the injector is in a restarting position as soon as the water supply is re-established.

One lever operation controls both the water and steam. As the operating lever is moved to regulate the injector, the proper relation of steam and water for highest efficiency is produced automatically.

The injector is both lifting and non-lifting and therefore may be located at the most convenient place on the locomotive. All parts are designed for a working pressure of 400 lb. per sq. in. to assure long life and low maintenance.



The Nathan Type 4000 injector is equipped with an automatic restarting overflow

EDITORIALS

Detailed Car Repair Costs

Time and labor required for the thorough analysis of detailed car-repair costs are well spent indeed. Take, for example, the figures compiled by an important western carrier for repairs made over a period of five years to a group of 100 single-sheathed box cars 20 years old. The total cost per car per year for repairs was $109.29, which may be compared with $59.28 per car per year for a similar group of 100 single-sheathed box cars only 10 years old. In the first instance, it is interesting to note that the largest single item of expense was for flooring, $22.05 per car, or 20.2 per cent of the total cost of maintenance per car per year during this period. The next largest item was $15.05 for lining. The application of a complete roof cost $11.06 and wheels $10.25 per car, per year. The total inspection cost $7.09; car doors, $4.63; draft gears, $4.17; and air-brake cleaning, $3.98 per car per year during the five-year period studied. On this road the average annual repair cost per car, or the total of Account 314 charges divided by the total freight cars owned, amounted to an average of $63 per car per year for the period.

Railroad Rolling Stock Being Reconditioned

With revenue freight-car loading at least 10 per cent higher than a year ago and net operating income in July, for example, 16½ per cent more than in July, 1939, it is interesting to note what the railways have been doing in the way of equipment maintenance and reconditioning. During the first six months of this year, the railways spent $397,126,782 for maintenance of equipment, an increase of $30,900,439, or 8.4 per cent over the first six months of 1939. With a somewhat smaller number of freight cars on line, the number of freight cars awaiting repair as of August 1, 1940, was 144,432, or 84,109 cars fewer than a year ago. Similarly, the number of locomotives needing repairs, as of August 1, 1940, was 6,506, or 1,933 less than on August 1, 1939.

A study of the records for revenue freight-car loadings indicates that they are running roughly 10 per cent higher than for corresponding periods a year ago and 20 per cent higher than two years ago. If present trends continue, the railroads may expect to have to handle close to 950,000 revenue freight-car loadings during the peak week of the year, which usually occurs about the middle of October. It is gratifying to note, therefore, the attention given in recent months to reducing the amount of equipment held awaiting repairs, for it will all be greatly needed during the peak loading period if car shortages in all classes of equipment are to be avoided and sufficient motive power be available to move the trains promptly.

No doubt particular attention will have to be given to particular classes of cars which may be in greater demand than other classes. For example, present demands for the shipment of national defense traffic requiring large capacity box cars indicates a need for supplementing the supply of 50-ft. box cars as fast as practicable and handling them in such a way as to assure prompt return to the owners for reloading with minimum delay.

Boilermaking With Micrometers

Workmanship is an important factor affecting the performance of any machine. The remarkable dependability and low cost of the automobile is sufficient proof that precision methods of manufacture are justified. It has taken the competition of locomotives powered by internal combustion engines to accelerate improvements in the steam locomotive and to show the need for not only better designs but for construction methods of more scientific exactness. Most of these improvements have been in the form of refinements in the running gear and motion work. More recently, attention has been directed to the fact that the boiler construction methods of yesterday must be revised to meet the requirements of the high-capacity locomotive of today.

Boilermakers have, for the most part, looked upon micrometers and what they stand for as complete strangers. Among the many expressions used in the backshop none has been spoken more frequently than "His rule only reads to the quarter inch, he's just a boilermaker." This remark may have been spoken in a joking manner, yet it typifies the relative crudeness with which boilers have been fabricated. It may be argued that a part as large and awkward to handle as a boiler course or shell does not lend itself to the precision

methods employed to form the smaller machinery parts. However, locomotive builders and a few railroads have not only recognized the need for better constructed boilers but are actually building boilers to tolerances associated in the past with work finished on machine tools. Boiler courses formed to fit together within five thousandths of an inch, cylindrical courses that are really round, sheets shaped to make a metal-to-metal contact with the connecting part without forcing, rivet holes drilled and reamed to the exact size are only a few of the refinements being practiced.

A committee of the Master Boiler Makers' Association, in submitting a report on boiler fabrication at the 1940 annual meeting, showed that this organization recognized the value of using more care and skill in the construction of boilers. In presenting this report the chairman stated, "The committee desires to recommend to the association only such methods which we know are attributes of first-class workmanship. We believe the standards set up by the association should be consistent with the scientific design of boilers and the demand which is being made for keeping the power in operation continually." This group of practical men are doing their bit towards keeping the steam locomotive in a position to meet successfully any competition. The subject is of such importance to the association that it recommended the study be continued in co-operation with the A. A. R. and the locomotive builders with the setting up of standard practices for boiler construction as the objective.

The trend toward better fabricating methods is partly the result of the boiler problems created by the use of higher pressures and the introduction of alloy steels. It has also been influenced by the investigation of embrittlement in which poor boiler construction has been found to be one of the contributing causes. Regardless of the reasons, it is certain that the locomotive boiler receives enough rough treatment in service without being placed under an initial handicap by anything less than the best workmanship.

Applying Locomotive Crank Pins

One of the editors of this publication recently heard what sounded like a small explosion as a suburban train was leaving a local station and, on going up ahead, discovered that the locomotive motion work was pretty well stripped on the left side, with the rods disconnected and the piston half out of the cylinder due to failure of the left main crank pin. A rough measurement indicated about two-thirds old break and one-third new fracture in the crank pin just inside the wheel seat. Fortunately, the crank pin failed before the locomotive had reached any appreciable speed, consequently the damage was relatively less than it might have been.

The entire question of driving-wheel maintenance, particularly as regards the application of both axles and crank pins, is being intensively studied by railway mechanical officers with a view to preventing even the occasional failures which present such a hazard to railway operation. In the instance cited, it is obvious that the progressive fracture in the crank pin could not have been detected by casual inspection. The partial or complete removal of the pin, however, and testing with the Magnaflux method would unquestionably have shown up the progressive fracture.

It appears clear that definite and possibly somewhat shorter periods of service life should be specified for axles and crank pins, especially in locomotives assigned to high-speed schedules, and apparently, in some instances at least, it will pay to review carefully every detail of wheel-shop practice and make sure that the latest approved procedure is followed, as well as the best modern machinery and equipment utilized to reduce failures to a minimum. Railroad shop men and terminal forces are notably ingenious in getting tough jobs done by one means or another, but uncontrolled methods and inadequate tools cannot be tolerated in such vital operations as wheel and axle reconditioning work.

What Is A Railroad?

Two of the addresses by railroad officers at the open meeting of the Association of American Railroads, held at New York on November 13 and 14, discussed the future of the railroad industry with a shift of emphasis from the points at which most such discussions have been directed. One is ominous in its note of warning; the other sounds a distinct note of optimism. Considered together, they present a challenge to the leaders in the industry—the responsible officers of the organizations which represent and lead the workers in the industry. Together, they cover both of the essential relationships of the industry: that between the managements and the employees and that between the railroad organization as a whole and the public it serves. Both stress the significance of the change from the days when railway transportation constituted a monopoly to the highly competitive situation in which the railways must fight for their lives today.

The Monopoly Mind in Employee Relations

Jacob Aronson, vice-president, law, New York Central System, speaking on the need for labor's co-operation, said that "for some years it has been obvious that, for all practical purposes, competition has superseded the constitutional right of a reasonable return on investment. Rates no longer can be made on the primary basis of the cost of service (that is to say, on the basis of producing a reasonable return on the cost or value of the plant) but must take cognizance, and frequently paramount cognizance, of com-

petitive conditions. Railroad management has come to an awakening, sometimes to a rude awakening, that prohibitively high rates frequently 'kill the goose that lays the golden egg!'

"Railroad labor might well take a leaf out of this book. Proposals that are economically unsound, that ignore the existence and expansion of competition and that entail cost beyond the legitimate capacity of the industry, are not only negatively shortsighted, but constitute affirmative injury to the very ones intended to be served. To the extent that artificial impediments are insisted on, which make the cost of rendering the service prohibitive, the business dries up. Employment is then reduced and the juniors find themselves on the "extra" board. . . .

"If the responsible heads of the Railroad Brotherhoods will call a truce on all efforts to create unwarranted jobs and working conditions and will unite with management in a concerted and vigorous effort not only to retain to the rails the traffic which now moves over them, but, as well, to get their full share of any expansion of business, they will undoubtedly be doing more to create additional jobs and heavier pay envelopes than can be accomplished in any other way."

The Monopoly Mind in Customer Relations

E. E. Norris, president of the Southern, speaking on the need of the railroads to rid themselves of the "monopoly mind" said that he liked to think of a railroad "not as an aggregate of inanimate locomotives and cars and tracks and buildings, but as a virile army of men and women working together to provide an essential service. I like to think of a railroad in terms of human activity, rather than in terms of physical property. . . .

"From this concept of a railroad, stems the thought that the improvement of railroad service must concern, *first of all,* the men and women who comprise the railroad family. That means the fellows at the top, those at the bottom, and all those in between. That means that the *starting* point for improvement in railroad service must lie in the minds of railroad people—in their attitudes; their mental processes; and their resulting actions. That means that if we really want to improve railroad services we've first got to improve our will and our capacity to please. . . .

"We must remember—and we must forget, at the same time—that, for 50 years, the railroads had a monopoly in transportation. That fact naturally produced what we might call—for want of a better name—the "monopoly mind" in *all* the ranks of railroading. . . . We have competition now everywhere—keen competition. Our competitors are young and vigorous. Their personnel has no inhibitions; no heritage of monopoly attitudes. . . .

"If you don't believe there *is* a difference between the attitude and actions of railroaders generally and the attitude and actions of the workers in competing transport agencies, try what we tried on the Southern Railway a year or so ago. Gather together a group of the keenest minds on your railroad. Tell them to forget that they ever earned a nickel of railroad money. Then send them out to call at railroad stations and offices, at airline terminals, and at the offices of the bus and motor truck lines. . . .

"The report your men will turn in—if it is free of prejudice—will probably shock you. In fact, I'll guarantee that it will! Our report from just this procedure certainly jolted us. So much so, that we still consider the job of *humanizing* the Southern Railway to be our *first* objective in the fight to live as a solvent, useful enterprise. So much so, that I am convinced that the first and most important step in any sincere effort to improve railroad services is the task of finding some cure for the hang-over from yesterday's monopoly jag."

Impaired Confidence Must be Restored

Taken together, these two addresses present a remarkably clear picture of what must happen if the railway is to marshal its forces for the fight to keep and develop the field of transportation to which it is legitimately entitled. Mr. Norris emphasizes the need of the railroads to rid themselves of the monopoly mind in their relations with the public. Mr. Aronson asserts that the employees must get rid of the monopoly mind in their relations with the managements and, through them, with the public.

Herein lies the challenge to management. The accomplishment of these two essential changes in attitude places a responsibility on railway officers to take the lead in improving the "will and capacity to please" in all employee relations. But it will not be enough that these relations be established on a more warmly human basis. The same forethought and skill must be brought to bear on the development of a campaign of education for improving these relations that has been and is being devoted to the present campaign for the improvement of the relations of the railroads with the public.

And above all, such a campaign, to have any possibility of succeeding, must be wholly free from sharp practice, or half truths. There must be complete candor if the confidence of employees in management—which too much preaching of class consciousness and class hatred during recent years has impaired—is to be restored. Until that confidence is restored, there is little hope of making real headway in the educational part of the program to rid railway employees and their leaders of the monopoly mind which justifies "importunities for continual Congressional discriminatory favors at the expense of the railroad industry." Until that confidence is restored, the railroad will continue to be a complex aggregate of physical property subjected to the abuse which comes from the cross purposes of the men who manage it and the men who operate it. Only when that confidence has been restored is there hope that it may again become "a virile army of men and women working together to provide an essential service."



The "Igloo" occupies a space 25 ft. by 55 ft. when buried under eight carloads of sand

A. C. L. "Igloo" Sand Drying House

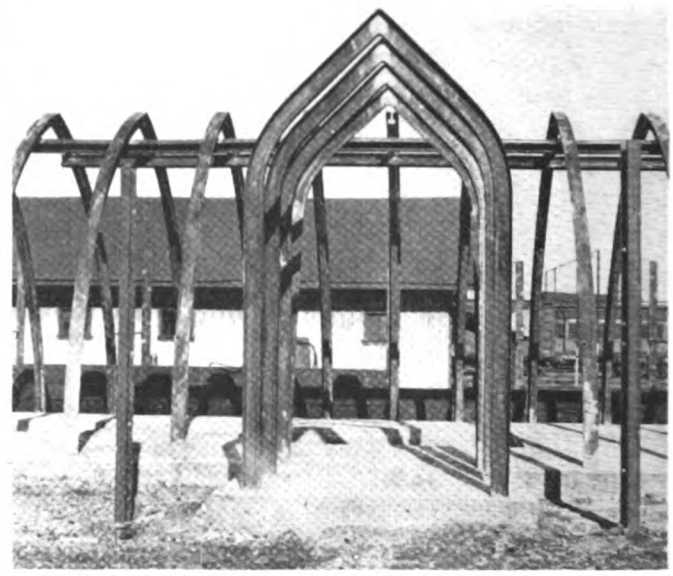
*By C. L. Meister**

In May of this year an unusual type of sand drying house was placed in operation at the Florence, S. C., shops of the Atlantic Coast Line. It is called the "Igloo" because the lines of the roof are similar in appearance to those of the Eskimo dwelling. The house was designed especially so the sand could be unloaded from the cars by the shop crane, dumped directly on the roof, and then made to flow by gravity to a convenient location near the stoves, thus reducing the labor requirements for handling.

The sand house was constructed of old rail, scrap roof sheets from old cars, condemned air reservoirs and other second-hand material with a suprisingly small cash expenditure for foundation materials and some valves and fittings. The frame is made of the old rails which have been bent to form the slope of the roof and set in concrete as shown in one of the illustrations. The roof and sides are of 3/16- or 1/4-in. plate. The side sheets only extend down to within three feet of the ground, leaving an opening through which the sand falls inside the house near to the stoves. The sand house was set inside of a retaining fence and occupies a space 25 ft. by 55 ft. with eight carloads of sand.

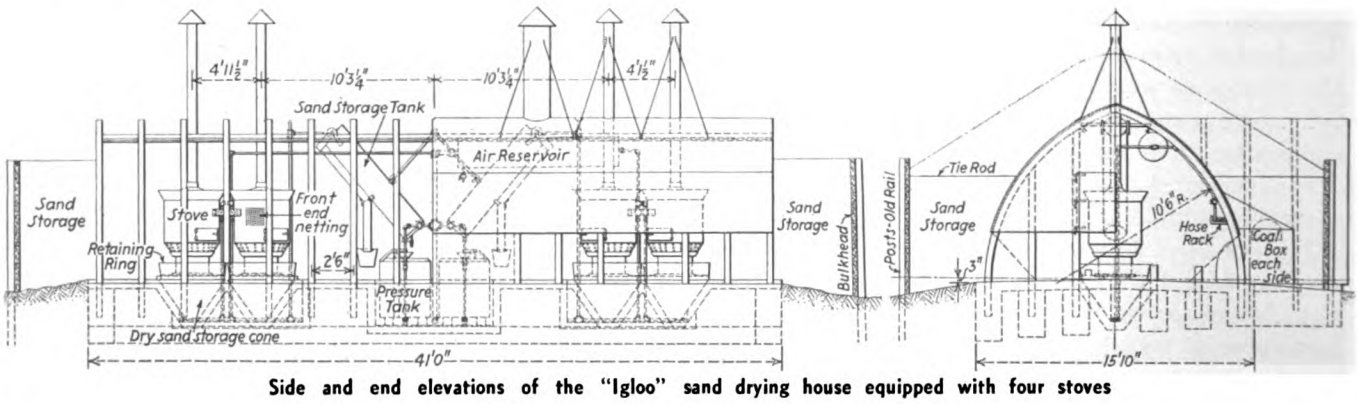
The dry sand drops into concrete-lined conical pits under each stove from where it is carried by compressed air to one of two storage tanks that are installed near the center of the house at an angle of approximately 45 deg. as shown in the diagram. The sand falls from these tanks directly into pressure tanks and then is lifted by compressed air to two large outside tanks set high above the tracks, where it is available to replenish the supply on the locomotives.

The sand is screened three times before it reaches the outside tanks. There is a screen in the top of the conical pit under the stove. It is screened again as it is blown into the storage tank and it goes through another in the funnel that guides the sand into the pressure tank. Trash material, which is caught by the screen at



Old rails welded together form the frame of the sand house

* Mechanical engineer, Atlantic Coast Line.



Side and end elevations of the "Igloo" sand drying house equipped with four stoves

the top of the storage tank, is conveyed through a pipe to a bucket suspended under the tank.

Since placing this sand drying house in operation, it has been found that about 50 per cent of the moisture in the sand on the roof is removed by natural evaporation and the elimination of the balance requires but a small amount of artificial heat. During the past summer only two stoves were fired and even these were allowed to go out for several days at a time. The average demand for sand at the Florence terminal varies from three to four tons per day in the summer months to over six tons a day during the winter season. It is the intention of the Atlantic Coast Line to build, as required, similar sand houses equipped with two, three or four stoves at other locomotive terminals.

Laying Out Shoes and Wedges On a Vertical Turret Lathe

A Bullard vertical turret lathe with a universal chuck can be used to advantage in laying out shoes and wedges. Here is how it can be done.

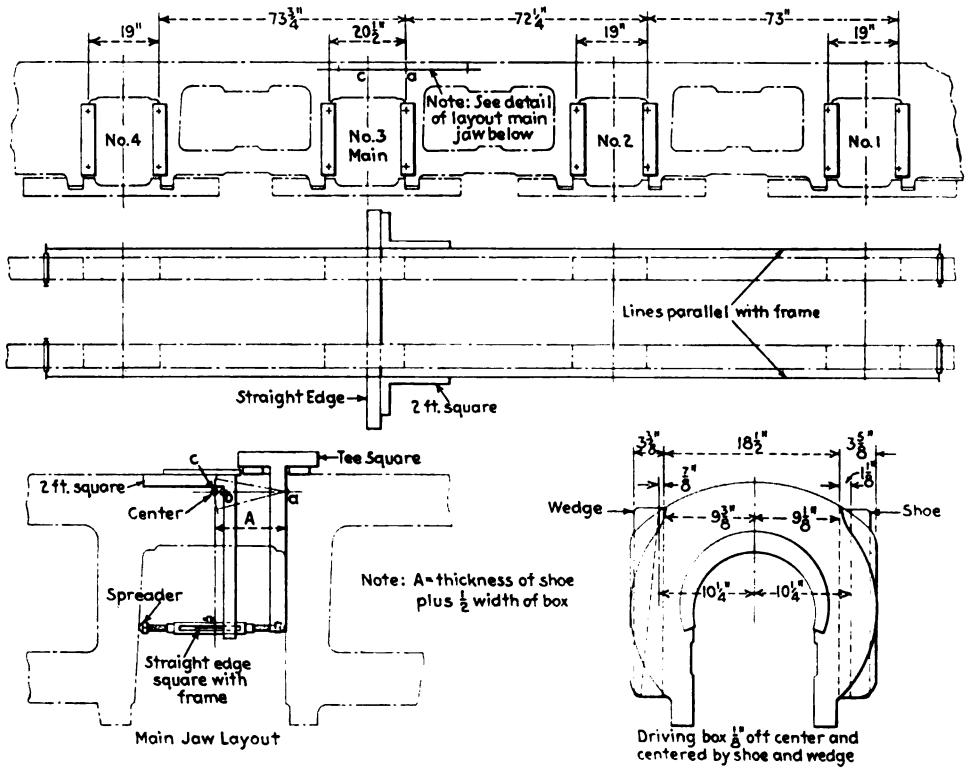
Place the driving box on the boring-mill table and if it is found to be out of center, as shown in the lower right corner of the accompanying drawing, a liner or parallel is placed in the chuck on the thin side of the box, before the box is bored. One-half the thickness of this liner is the distance the box is out of center.

For example, the driving box shown is 18½ in. wide and a ¼-in. liner is placed on the thin side of the box before boring. One-half the thickness of the liner, or ⅛ in. is the distance the box is out of center. Since the shoes and wedge are laid out at a standard 1 in. thickness, it is necessary to add to the shoe the distance of ⅛ in. that the box is out of center, making the shoe 1⅛ in. and to subtract the same distance from the wedge making it ⅞ in., or vice versa.

This saves the time of centering each box and by using this layout for shoes and wedges, the locomotive may be laid out before the boxes are bored, as the work is done from the center of the driving box and not from the frame centers. This eliminates marking the centers on the frame, except on the main jaw and the spring rigging may be left on or applied to the engine during the layout, except on the main jaw.

Then proceed to layout the shoes and wedges according to the standard method, as shown. This method can be used on all types of locomotives.

Another time saver in this method of shoe and wedge layout is that if the main center is out of square, the error can be placed all on one side of the frame. This saves the time of dividing the error on the frame, because this can be done easily, on paper or mentally. For example, the center on the main frame is out ⅛ in. and the box is 18½ in. at the 1-in. shoe-and-wedge layout. When the error is divided the shoe will be $^{15}/_{16}$ in. and the wedge $1\,^{1}/_{16}$ in.



Drawing of frame and driving box showing method of laying out shoes and wedges

Locomotive Boiler Questions and Answers

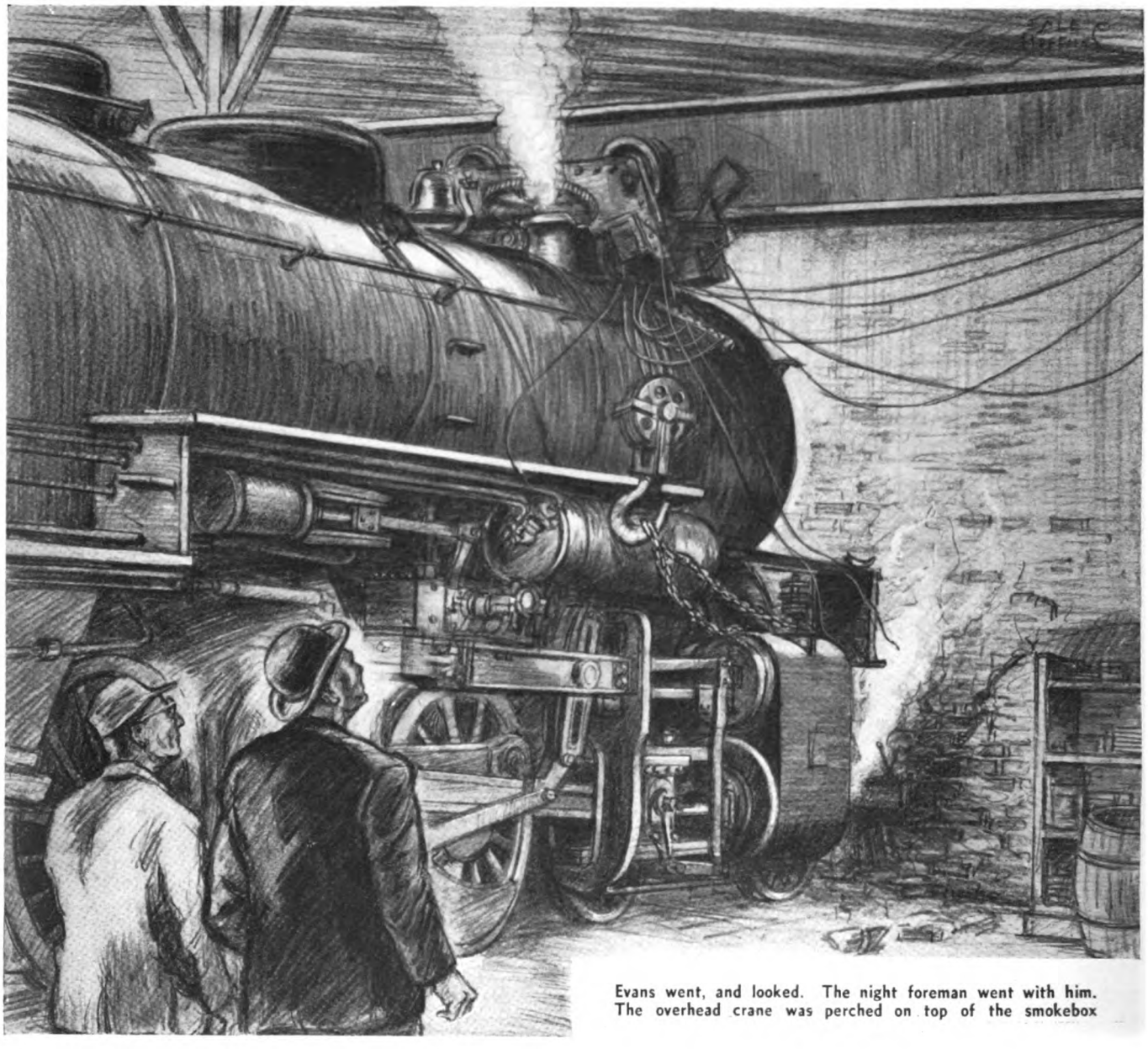
By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Repairing Grooved and Corroded Wrapper Sheets

Q.—The wrapper sheets of several of our Pacific type locomotives are grooved and corroded directly above and running

(Continued on page 549)



Evans went, and looked. The night foreman went with him. The overhead crane was perched on top of the smokebox

IT'S AN ILL WIND

by

Walt Wyre

MAYBE Confucious said it and maybe he didn't, but every railroad man knows when things are running along smoothly trouble is not far behind. Everything in the S. P. & W. roundhouse at Plainville had been going smooth as a ballbearing baby carriage going down hill. There hadn't been an engine failure or a personal injury in nearly thirty days. Things had been going so nicely that Jim Evans, the roundhouse foreman, who has been going to quit railroading for twenty-eight years, had just about decided to stay with it.

The chief despatcher started the trouble when he called the roundhouse office Wednesday morning and said that there would be a heavy shipment of cattle Saturday and that two 5000 engines would be needed.

"That should be easy," Evans said. "The 5088 should be ready to go and the 5092. This is one time we are one jump and two engines ahead."

The boilermakers were renewing the side sheets of the 5088 and machinist Jenkins had just started to bore the cylinders of the 5092. The boilermakers were just about ready to start driving rivets at the time the despatcher called.

Evans took a turn through the roundhouse and then went back to the office. The foreman had just settled down comfortably with his feet on the desk when a boilermaker helper came in.

"There's not enough air to drive rivets," the helper said.

"What's the trouble; isn't the air compressor running?"

"I don't know," the helper replied. "Barton just told me to tell you there wasn't enough air to drive rivets."

At that moment Louis Johnson, a machinist, came in. "The air compressor is broke down," Johnson said. "I was passing by the stationary and heard the compressor pounding like it was going to start flying to pieces any minute. I shut it off."

"Did you find out what's wrong with it?" Evans asked.

"Well, for one thing, two crank shaft bearings are knocked out. Don't know what else is wrong with it."

"That's enough!" Evans got up and started out to look at the compressor. The machinist went with him. "They've been promising us a new compressor for the past seven years," Evans said when he looked at the machine. "If they're ever going to get one it's time they did it. W've spent enough patching up this one to have bought at least two. Get your helper and take the bearing caps off and see what condition the shaft is in," Evans told the machinist.

When the foreman left the stationary room he met machinist Jenkins. "I've got the boring bar set up to start boring the left cylinder and there's not any air," Jenkins told the foreman.

"It may be tomorrow before we get the air compressor going," Evans replied. "You can take the heads off the other cylinder and get it ready while you're waiting."

It was but a matter of minutes to loosen the cap screws that held the bearing caps and it took less time than that to tell that the shaft would have to be smoothed before pouring new bearings if it was to run. The machinist and helper worked the rest of the day and an hour overtime. The shaft needed grinding but they weren't prepared to do it even if they had time. They knocked the worn spots off with a mill file, then polished it with emery cloth, poured new bearings and called it a job.

NEXT morning just before eight o'clock, Evans went out and started the compressor. It sounded like twin pile drivers driving steel piling through bed-rock. The foreman hurriedly closed the throttle and went to find machinist Johnson.

"Say, that compressor sounds like it was ready to fly all to pieces. Better take a look at it soon as the whistle blows."

"What are we going to do for air to drive the rivets on them side sheets?" Barton, the boilermaker, asked.

"Well, I guess we'll have to use an engine. I'll tell the hostler to run the 5091 in and use it to furnish air for the roundhouse. The car department will just have to get along somehow until we get the compressor going again."

The air pumps on the 5091 worked faithfully and well, but just didn't have the capacity for the job. It seemed that every one that ever used air at all needed it that day and there wasn't enough. The painter spraying paint, the blacksmith forge, the pipefitter's furnace, a rivet forge—all required air to operate and all were in use. Evans noticed a machinist using an impact wrench or rather attempting to use one with about forty pounds of air and stopped him. He felt like firing the laborer that cleans the machine shop when he found him using air to blow dust and shavings out of the machines.

The foreman stopped and watched Jenkins trying to bore a cylinder. The air motor sounded like a fat man climbing a mountain and was making about as much headway. Evans had threatened several times to rig up an electric motor to run the boring bar, but hopes of eventually getting a new boring bar already equipped with a motor had been partly responsible. Then, too, when using the boring bar there wasn't time and when it was not in use no one thought about it. Evans watched a few minutes and decided it would save time in more ways than one to do it then. It would at least allow more air for other jobs that needed it.

"Say, didn't you tell me that you had a two horsepower motor that wasn't in use?" Evans asked Ned Sparks, the electrician.

"There was one here," Sparks replied.

"Where is it now?"

"It's in the lumber shed if the storekeeper hasn't sent it in," Sparks said. "Do you want me to see?"

"Yes; bring it up here and see if it's in condition to run. Get it right away; I want to hook it up to run the boring bar."

The motor was still in the lumber shed and in condition to run, but there were no pulleys of the proper size available. Evans hadn't considered the fact that the electric motor ran at approximately 1,800 r. p. m. while the air motor only ran about two hundred. That would require a nine to one reduction to operate the boring bar at the same speed as did the air motor; however, the boring bar speed could be increased slightly without running too fast.

The foreman decided that a 3½-inch pulley on the motor and one of 28 in. diameter on the boring bar would be about right if he had the pulleys. The smaller one could be turned in the machine shop, but the larger one couldn't. He searched the place over, but there wasn't a pulley of even approximately the right size to be found. He was ready to give up and continue to try to use the air motor until a pulley could be ordered. He went to the storeroom to tell the storekeeper to order a pulley.

The storekeeper had stepped out a few minutes and Evans looked around in the storeroom while waiting. He happened to glance up and saw what appeared to be the rim of a pulley projecting over the edge of a material rack. He climbed up for a look. What he thought was a pulley was one of four brand new wheels for a truck. Evans started to get down then changed his mind and climbed up for a better look. He took one of the wheels and climbed down. He measured the wheel. It was 26 inches in diameter, the rim was 3 inches wide.

The storekeeper came in while Evans was measuring the wheel. "That's one of the wheels for our truck," the storekeeper said. "Do you want me to order you some of them?"

"No; order one for yourself," Evans said, "unless you can get along with three." The foreman started off carrying the wheel.

"Say, you can't do that!" the storekeeper yelled. "I need that wheel!"

"Not as bad as I do," Evans replied and kept going.

The bore of the wheel was too large for the shaft on the boring bar, but that was soon corrected by making a bushing. A machinist made a pulley for the motor out of a piece of brass.

"How are we going to fasten the motor," the electrician asked.

"Well, let's see," Evans pondered a moment, "I'll bolt it to a piece of heavy oak timber that should hold it."

It took half of the day to get the motor rigged up to run the boring bar, but it did a good job. The machine cut faster and smoother and left more air for the riveting job.

Friday at noon both engines were ready to go. Evans

went home that evening feeling pretty good. Two whole engines ready to go twenty-four hours before they were needed! That's enough to make any roundhouse foreman shake hands with himself.

Untroubled and for once without worry, Evans slept like a tired child and woke up next morning feeling fit as the proverbial fiddle. The motor of his three-year-old car purred like a kitten as he drove to the office. The night foreman came out to meet Evans looking like the personification of bad luck hunting a place to happen.

"What's the matter?" Evans asked. "Have a hard night?"

"Go look in the machine shop," the night foreman said.

Evans went, and looked. The night foreman went with him. A 5000 locomotive had its pilot jammed into the brick wall at the end of the machine shop. The overhead crane was perched precariously askew on top of the smoke box. Cables, trolley wires, and twisted angle irons were tangled in what looked like a hopeless maze.

Evans, looking a year older at each step, walked to the front end of the locomotive. The headlight was smashed beyond repair, both classification lights were broken off, and the stack light was crushed under the crane.

"I was afraid to try to pull the engine out," the night foreman said, "afraid the crane would fall."

"How did it happen?" Evans asked dolefully.

"Well, you see there wasn't any air pump on it," the night foreman explained. "The pump was reported and after we took it off to change it, I decided to change a pair of tank wheels that had been running hot." The night foreman sighed deeply and went on. "I asked the hostler if he could run the engine over the drop pit without any air and he said he could. There wasn't much steam on her; if there had been I guess it would have took out the whole wall. Anyway, he cut steam in the air reverse and spotted the engine on the table without any trouble. When he tried to stop on the drop pit the throttle stuck open and the reverse wouldn't work."

"Well, it's a helluva mess," Evans commented. "Good thing the engine wasn't called."

"But it was called," the night foreman said. "It was called to run west on an extra. There was an hour and ten minutes delay getting the 5092 ready."

"Well, I'll have to dig up another engine for one of the cattle trains," Evans commented thoughtfully. "There's still the 5088."

"I run it east on 72," the night foreman admitted. "The 5076 that I was figuring on had flat spots on the right main driver. I would have run it anyway, but I got word that the Federal Inspector was on the east end of the division."

"O. K.," Evans said as though he were facing a firing squad and ready for them to shoot. "I'll get along some way."

Machinist Johnson in the meantime had torn down the air compressor and found it ready to ship to Japan as scrap iron. Among other parts required to put the compressor back in service was a complete set of valves.

Evans had already told the storekeeper to wire for two extra locomotive air pumps to use until the compressor could be repaired. Evans went to the roundhouse office and called the B. & B. gang to come and straighten the crane around and get it back on the track so the locomotive that was under it could be pulled back. For once the gang was in town when needed and would be on the job at eight o'clock. That helped some, but didn't provide the two engines promised for the cattle trains and didn't get the ones out for the regular trains.

When the whistle blew the foreman lined the work out and got the men started on the daily routine. He told the electrician to look at the damaged engine and get the necessary repairs together to fix it up as soon as it could be pulled back in the clear. A machinist was told to take the dome cover off and see what was wrong with the throttle.

About nine o'clock, master mechanic H. H. Carter came to the roundhouse. That worthy official did everything but turn handsprings when he saw the mess the 5094 had made in the machine shop. Then Evans told him about the air compressor tearing itself up. Carter swore a few verses about that. "Did you have the storekeeper wire for repairs?" he asked.

By then Evans was about ready to do a little blowing up himself and didn't care much what the result might be. "No, I haven't wired for parts for the compressor. I sent for two locomotive pumps. They've been promising us a new compressor for the past ten years and I'm through trying to keep that old wreck running. It takes half the time of a machinist trying to keep it repaired and every time we need air there isn't any."

Carter had already blown off most of his surplus steam and had cooled down somewhat. "I don't blame you," he said. "I'll wire the S. M. P. that it's impractical to repair the compressor, then maybe we'll both get fired."

The B. & B. gang made good time jacking up the overhead crane and getting it straightened around. At 10:30 they had it in shape so the 5094 could be pulled back in the clear. The machinist found the throttle disconnected and soon had that part repaired, but the front end still looked like it had come out second best in a Kansas cyclone.

After checking up, the only two locomotives available for the cattle trains were the 5094 and 5076. If there had been a tire of the proper size and thickness to fit, getting the 5076 wouldn't have been much of a problem. One would have to be bored out and turned to size. The crane being out of commission complicated things, too. Not only was the overhead crane broken down, but scaffolding put up by the B. & B. gang had the way blocked so the portable crane couldn't get to the wheel lathe with a tire. Nevertheless, a tire had to be turned and Evans decided to do it if it took all hands and the cook to get the job done. He got together a gang and rolled a new tire into the machine shop and then rigged up a chain hoist to swing the tire and chuck it on the face plate of the wheel lathe. After it was bored it was a comparatively easy matter to change the chuck jaws for turning the outside of the tire.

By the middle of the afternoon a little daylight could be seen through the cloud of trouble. The 5076 was just about ready to set outside for one of the cattle trains, but the electrician was having trouble with the 5094. There wasn't a headlight in the storeroom, just one classification light, no stack light, and flexible conduit for the job would have to be ordered.

"Don't know what we would do if there wasn't usually an engine tied up," Evans said when the electrician told him about it. "Take what you need off the 5081 on the drop pit."

"That might be O. K. if you didn't need the engine until about noon tomorrow, but working alone I wouldn't have time to take all of the wiring and things off the 5081 and get them back on the 5076," the electrician said, "and besides, the flexible conduit that goes to the headlight is shorter than that on the 5076 and wouldn't reach."

"Well, get it going somehow," Evans left the proposition up to the electrician, "I'll give you a helper. Hang the lights on it so it will do to run."

It wasn't a very good looking job that the electrician did, but it at least complied with what the foreman had requested. Sparks fastened the headlight, stack light, and classification lights in place, then ran wires to them.

He wrapped the wires with a layer of friction tape and called it a job and the despatcher had his engine with only twenty minutes delay.

Next day the master mechanic came to the roundhouse and Evans told him about fixing up the motor to operate the boring bar.

"Why don't you have a wagon made to mount the motor on and get a push button starter put on it," the master mechanic suggested.

Evans had suggested doing that very thing several times before and Carter had vetoed the idea, but the foreman didn't mention that.

The overhead crane wasn't in as bad condition as it had appeared to be. After the B. & B. gang got it back on the track it didn't look near as bad as before. The light angle-iron railing could be straightened up without a great deal of work and only three trolley wires had to be replaced. The big I-beams were slightly bent but not enough to affect operation.

Then came the best news of all—a wire from the superintendent of motive power: "New air compressor will be shipped next week."

"I guess the old saying is still true. 'It's an ill wind that blows nobody good,'" Evans commented when he read the message.

Locomotive Boiler Questions and Answers

(Continued from page 545)

parallel with the mud ring. These wrapper sheets are ⅝ in. thick. Is it permissible to weld the corroded areas or should the corroded section be removed and a patch applied?—D. E. F.

A.—The extent and the depth of the grooved and corroded area should determine whether or not a patch would be required. Corroded or grooved portions of wrapper sheets can be filled in or reinforced by welding provided at least 60 per cent of the original thickness of sound metal remains in the sheet. Grooved or corroded areas shall not be filled in or re-inforced by welding, if the width of the area exceeds 2 in., or the length 30 in., or if the welding is in line with staybolts or studs.

Two such areas in any one plate may be filled in or re-inforced provided the distance between the re-inforced surfaces is not less than 30 in. Building up around wash-out openings or blow-off pipe connections shall not exceed 2 in. from the edge of the hole. If the grooved or corroded areas of the wrapper sheets are more than ¼ in. in depth and more than 2 in. wide or 30 in. in length, the section should be removed and a welded patch applied.

Reduction in Boiler Pressure—Alteration Report Required

Q.—Is it required to file a boiler alteration report with the I. C. C. when reducing the working pressure on a locomotive, if the boiler is still capable of carrying the boiler pressure shown on the original specification card?—W. O. M.

A.—Rule 54 (b) of the Laws, Rules and Instructions for the Inspection and Testing of Steam Locomotives of Tenders and Their Appurtenances, states as follows: When any repairs or changes are made which affect the data shown on the specification card, a corrected card or an alteration report on an approved form, 8 in. by 10½ in., properly certified to and giving details of such changes, shall be filed within 30 days from the date of their completion.

It is customary to file an alteration report when any changes are made that affect the original specification card, even though no actual repair or change was made to the above boiler. The reduction in boiler pressure is a change in the information as shown on the original specification card and, therefore, should be recorded with the Bureau of Locomotive Inspection.

Flexible, Seamless All-Metal Hose

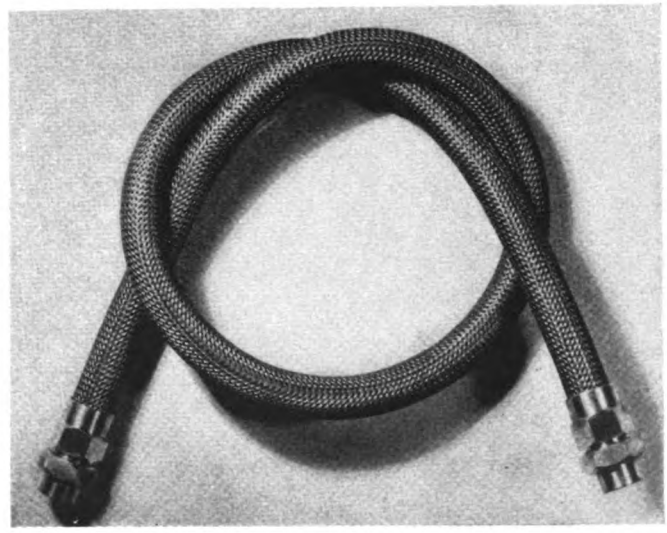
Seamlex flexible hose or tubing is extensively used on railroad equipment, particularly on locomotives where some of its applications include its use in force-feed lubricating systems, and in power reverse-gear, brake-cylinder, equalizer, signal, and booster steam lines. It is available in standard stock sizes ranging from 1/16 in. to 6 in. inside diameter.

This flexible hose consists of three essential parts, the inner seamless flexible tube, the outer covering and the couplings. The inner tube is made of a single piece of seamless tubing with helical convolutions giving it great flexibility. Due to its construction the corrugated flexible tube is as leakproof and free from seepage as the seamless tube from which it is made. For temperatures up to 400 deg. F. it is usually made of bronze. For higher temperatures steel is recommended. The inner tube is made with open-pitch corrugations for withstanding vibration and close-pitch corrugations for frequent flexing.

The outer covering consists of one or more tubular metal braids, depending upon the internal pressure to which the hose is subjected. The type of braid varies with the service in which the flexible hose is to be used. An additional outer armor is required where chafing or severe operating conditions prevail.

There are two principal classes of couplings, one being the solderless, brazeless, and packless construction for high temperatures. This class is furnished either in the flare or detachable types depending on the service conditions. The other is the triple-seal soldered coupling for use with lower temperatures. The couplings are furnished with a standard pipe thread or with any special thread that may be specified.

The flexible hose or tubing is made by the Seamlex Company, Long Island City, N. Y., with its sole sales representative being the Miller-Lewis Railroad Equipment Corporation, New York, N. Y.



The Seamlex all-metal hose is tied in a knot, indicating its flexibility

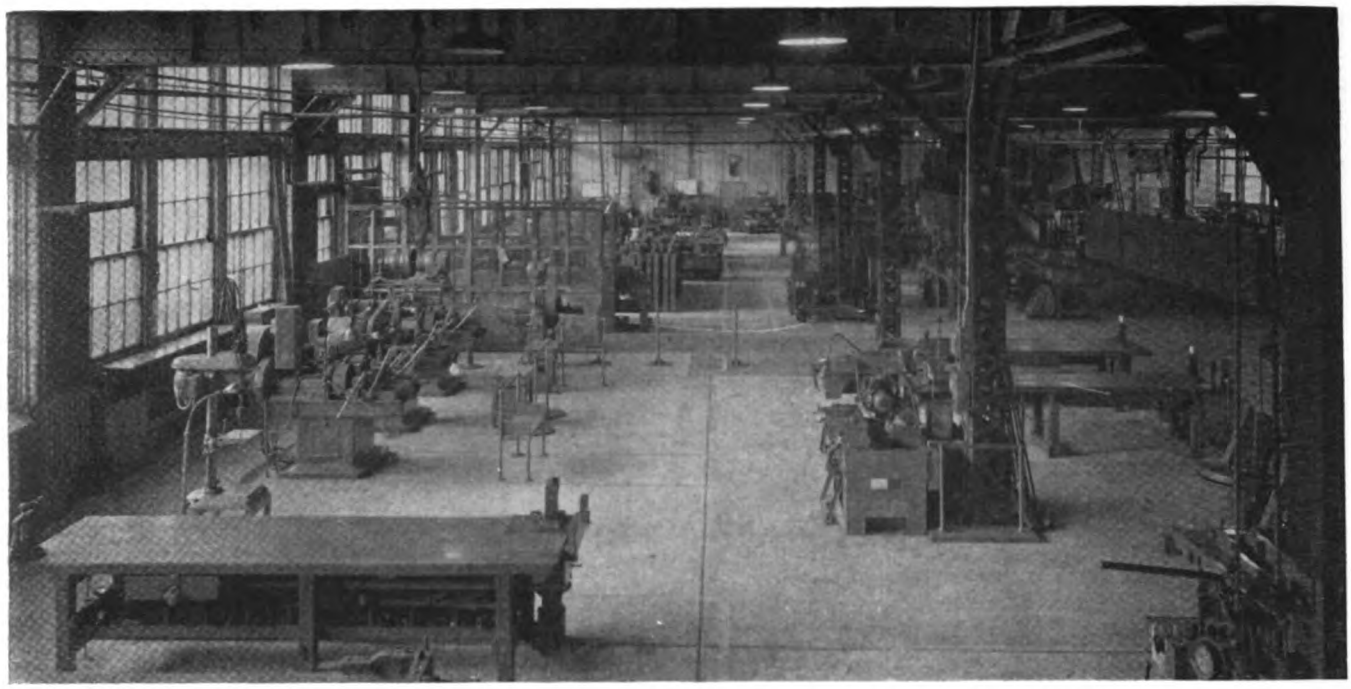


Fig. 1—The pipe and air-brake departments at the Milwaukee, Wis., shops of the C. M. St. P. & P.

Pipe and Air-Brake Shop Devices

*By T. H. Birch**

Much time and study have been given to laying out the pipe and air brake department at the Milwaukee shops of the Chicago, Milwaukee, St. Paul & Pacific. Safety First has been considered of primary importance, with the result that this shop has had only one personal injury in the last 10 years, with an average employment of about 45 men. Wherever an operation is performed in this shop, there is a sign facing the man doing the work, reminding him of safety. In addition to this, there are many operations where the use of goggles is deemed necessary; therefore, an additional sign is added which reads, "Goggles Needed." There are many other reminders of the importance of "Safety First" scattered conspicuously throughout the department. Aisleways are definitely laid out with yellow lines, and so are islands in which the various operations are being performed and where material is stored.

All operations have been analyzed and the proper sequence definitely decided on which has resulted in work being performed with the least possible number of movements of men and material. Fig. 1 is a general view of this department.

Another feature is an exhibit of sectional models of practically all the valves and equipment handled in the shop. These models have been obtained from damaged parts, so no material investment is incurred. They are a great help to the men in the shop in enabling them to become better acquainted with the work which they are doing. They are also beneficial to men employed in the

* Air brake foreman, Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis.

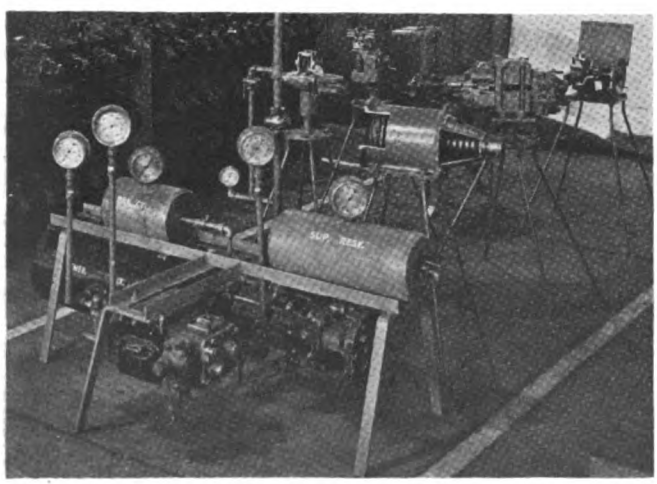


Fig. 2—Sectional models of air-brake valves and equipment.

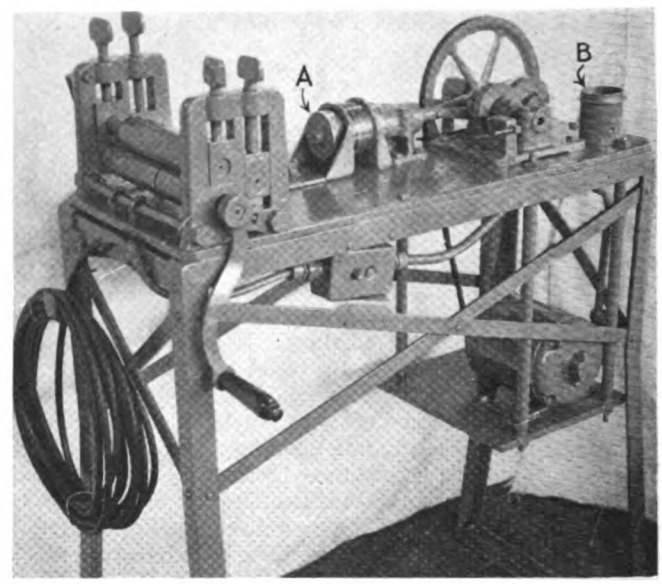


Fig. 3—Shop-made machine for reclaiming non-pressure-head brass protector rings.

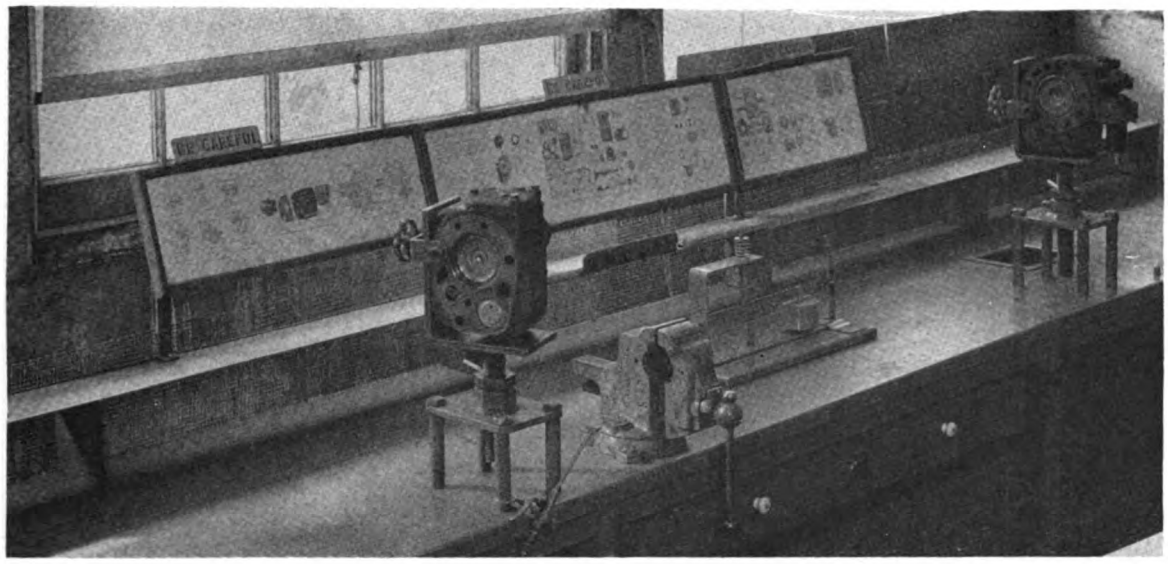


Fig. 4—Bench construction with wire mesh back stop which transmits light and facilitates cleaning.

terminals, many of whom avail themselves of the opportunity to study this equipment. In addition to these models, there is a working setup of a complete D-22-A control equipment and also an AB equipment connected with both a single-car testing device and an engineer's brake valve. These two setups have proved themselves very educational and instrumental in keeping the men interested in their work. A section of this exhibit is shown on Fig. 2.

A novelty of the bench construction, illustrated in Fig. 4, is that although there is a shelf attached to the back of the bench for small material, iron mesh is used for a back instead of a solid material. This not only provides light but also facilitates the cleaning of the benches and eliminates dirty corners, for a blast of compressed air will thoroughly clean the bench. Attached to the top of this bench is a series of enlarged photographs showing the various parts and the identification numbers of the AB valves. This assists the men in immediately recognizing and becoming acquainted with the various parts used.

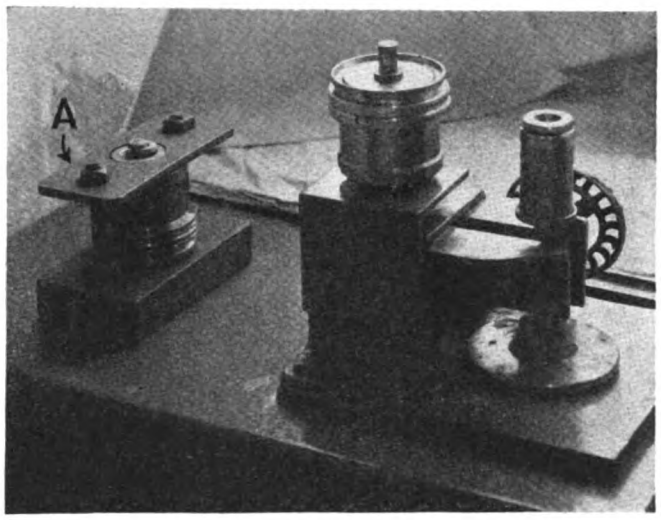


Fig. 6—Holding device for AB main piston and accelerated-release pistons.



Fig. 5—Clamping device for holding brake-cylinder piston.

Many tools and devices have been developed in this shop, and articles have been published on several occasions in the *Railway Mechanical Engineer*. Recently several other devices have been developed, all tending towards a better and more uniform method of air-brake maintenance.

Fig. 3 shows a home-made machine made with angle iron, a reciprocating part, a ⅛-hp. motor and a set of rollers. This machine is used in reclaiming the brass protector rings used in the non-pressure head of the AB brake cylinder. When these rings become worn to the extent that they are loose on the piston sleeve, they have to be renewed, then, instead of throwing away these rings, a small amount is removed from one leg of the ring, after which it is placed in the rollers and rolled until the ends again contact each other. The rings are then placed on a mandrel, shown at *A*, Fig. 3, this mandrel being of a hardened steel material on which a fine abrasive compound is applied. With the rings in place the machine is started and, with a reciprocating movement, the rings are lapped to a perfect circle and are again ready for use. However, before being again placed in service, they are gaged on a measuring device shown

at *B*, which is really a part of the piston sleeve on which these rings are used. At the end of the first year's operation, the use of this machine resulted in a substantial saving which will increase as the work increases.

Fig. 5 shows a clamping device for holding the brake-cylinder piston and compressing the release spring so that the parts in the non-pressure head can be removed for cleaning and inspection. A set of home-made tools is also shown. The ring at the upper left corner is a safety feature; it is dropped over the clamping device when the piston is in place so that the clamp will not be inadvertently released.

Fig. 6 shows a holding device for the main pistons and accelerated-release pistons of the AB valve. With the aid of these two tools, the dismantling of these two units is a simple matter. The device marked *A* is connected with a foot treadle underneath the bench and by stepping on this treadle the spring in the accelerated release piston is readily compressed so that the horseshoe washer is removed without effort.

Fig. 8 shows the construction of two pulling devices.

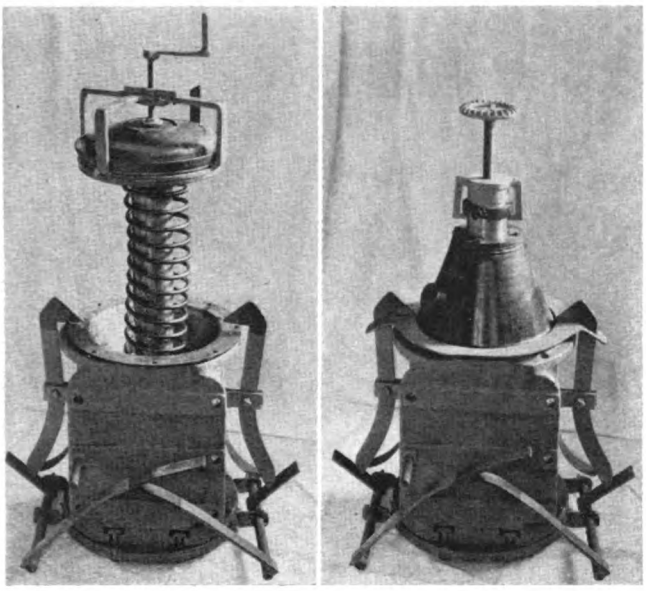


Fig. 7—How the devices for removing protector rings, packing cup and lubricating ring are used.

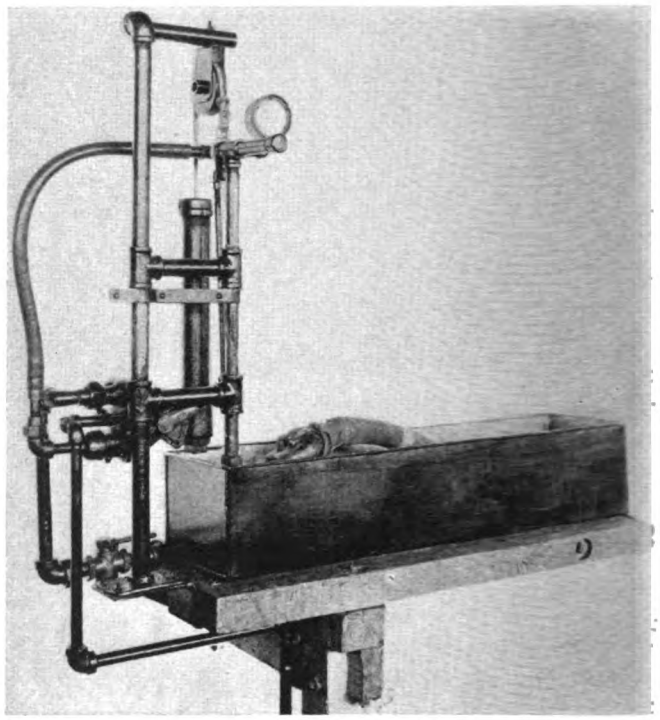


Fig. 9—Device for testing air hose after being reclaimed at Milwaukee shops.

Device *A* is used to remove the piston protector ring and device *B* to remove the packing cup and the lubricating ring from the piston. The application of these two tools is clearly shown in Fig. 7. Much time is saved by their use and many packing cups are saved from injury in the process of removal by other methods.

Fig. 9 illustrates a device for testing air hose. All the air-hose-mounting facilities on the railroad are concentrated at Milwaukee shops. During the stripping process of old hose sent in, a visual inspection is made, and any hose appearing good are laid aside and later tested with this device. The test consists of charging the hose with air pressure and then immersing the hose and fittings completely in water. The saving resulting from this procedure is very considerable inasmuch as the salvaged hose are again placed in service on system cars.

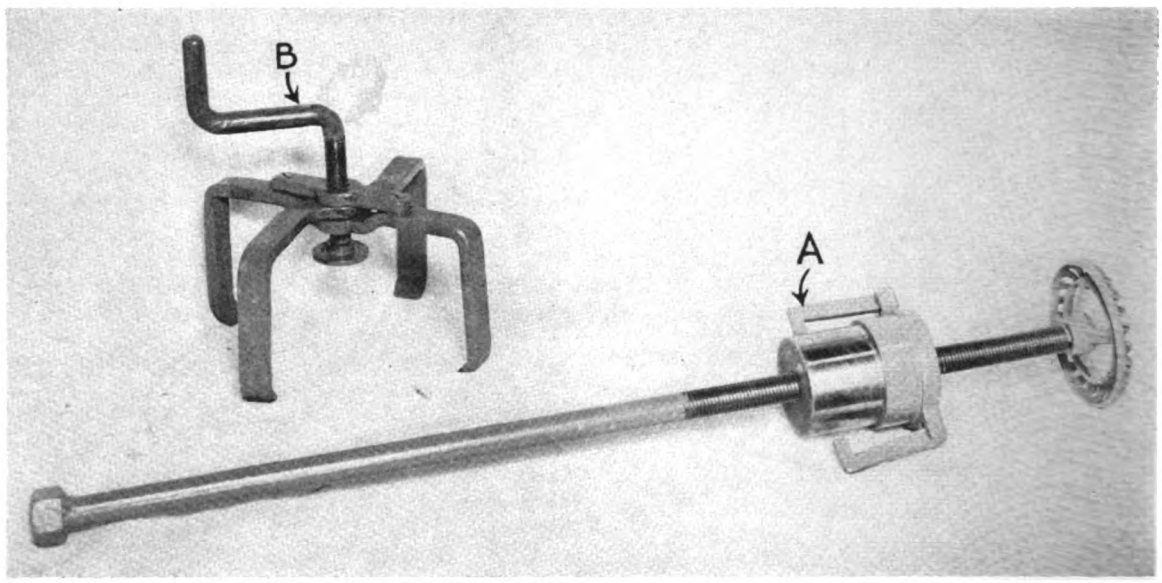


Fig. 8—Pulling devices—*A* for removing piston-protector rings and *B* for removing packing cup and lubricating ring.

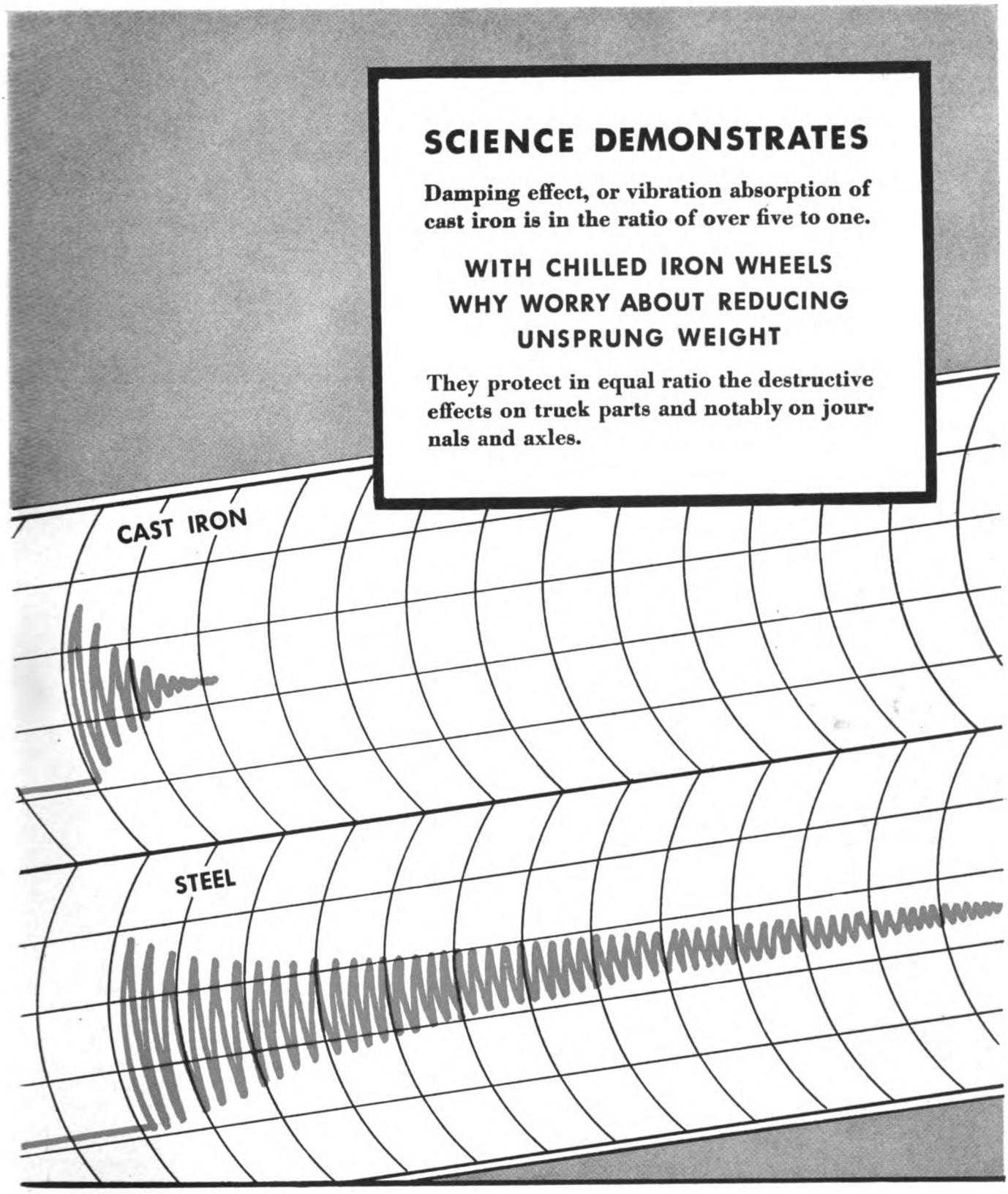
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SCIENCE DEMONSTRATES

Damping effect, or vibration absorption of cast iron is in the ratio of over five to one.

WITH CHILLED IRON WHEELS WHY WORRY ABOUT REDUCING UNSPRUNG WEIGHT

They protect in equal ratio the destructive effects on truck parts and notably on journals and axles.



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Repairing Box-Car Couplers and Draft Gears

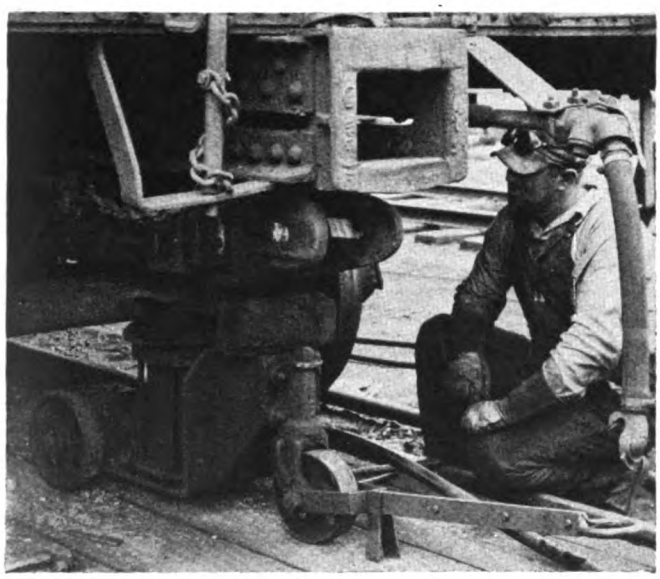
In making heavy box-car repairs at the Port Jervis, N. Y., shops of the Erie, a smoothly operating assembly-line method of production control is employed which enables the relatively small well-organized shop force to obtain production volume that would otherwise be impossible. The repair work has been broken down into various operations, each of which is performed at a certain position along the line. So that all operations are completed at the same time and the cars moved to next position, the entire work must be completely balanced.

Of particular interest is the position at which the coupler and draft gears are inspected and repaired. At this spot, a simple lifting device enables the workmen to drop and raise draft gears with minimum physical effort. So that the men can work freely, the cars are raised by a locomotive crane and the trucks are moved back under the center sill. Four-inch blocking is placed on the bolster to give additional head room. The cross key and coupler are then removed with the aid of a half-ton overhead air-operated hoist.

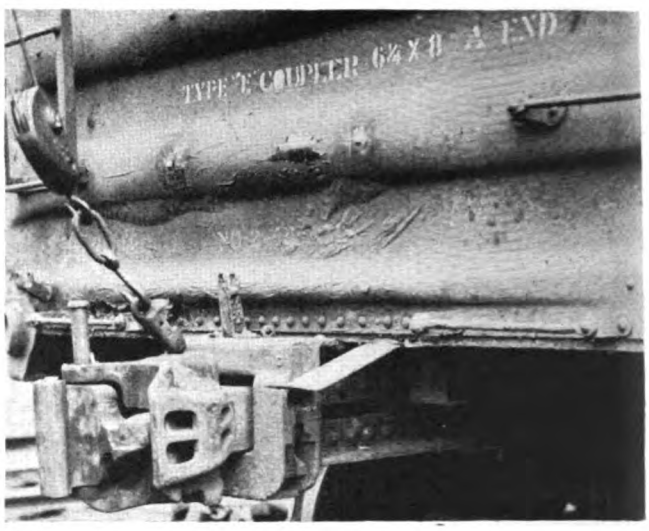
The draft-gear device consists of a cylinder with telescoping piston mounted on wheels. This machine has an over-all height of 21 in. and a total lift of 22 in. The outside piston is 10 in. in diameter, the inside piston is 8 in. The jack was built with telescoping pistons for two reasons—to produce the required lift and for the safety of the workmen. The 8 in. piston will not exert sufficient force to lift the car off the trucks should the draft gear stick while the 10-in. piston might cause this undesirable action.

In operation, the air jack is rolled into place under the draft gear and the piston is raised until the weight of the entire draft arrangement is removed from the carrier iron. A U-shaped plate attached to the end of the 8-in. piston permits the lifting force to be applied evenly on each side of the carrier iron. The rivets securing the carrier iron to the center sill are removed and the draft arrangement is then ready for lowering with the jack. The pistons are lowered carrying the draft gear into a position where it is readily inspected and repaired if necessary.

If a draft gear is defective and requires renewal, the jack and draft gear are easily rolled from under the car into a position where the gear can be changed with the aid of the overhead air hoist. After the inspection and repair operations are completed, the air jack raises the draft gear between the sills and supports it there until the carrier iron is applied.



The draft gear is removed and applied with the portable air jack—If necessary it may be moved out from under the car



The coupler is removed by means of an overhead air-operated hoist

Air Brake Questions and Answers

D-22-A Passenger Control Valve (Continued)

615—*Q.—What test should now follow?* A.—The brake-pipe leakage test.

616—*Q.—How is this test made?* A.—Observe the pressure on the brake-pipe gage; leakage from the brake pipe will be indicated by a drop in pressure which must not exceed 2 lb. in 1 min. A slight pumping action of the emergency piston, indicated at the quick action exhaust, will not affect the leakage test.

617—*Q.—What test should follow?* A.—The auxiliary reservoir leakage test.

618—*Q.—How is this test made?* A.—If the control valve releases the brake in less than 1 min., with the device handle still in position No. 3 (lap), it indicates a leak from the auxiliary reservoir, graduating valve, slide valve, auxiliary-reservoir pipe, or a leak into the brake pipe past the test device.

619—*Q.—What test follows?* A.—The release test.

620—*Q.—How would you make this test?* A.—Move the device handle to position No. 2. The piston and slide valve of the D-22-A control valve should move to release position within 20 seconds, plus 5 seconds for each pound of brake-pipe leakage.

621—*Q.—How long should the test be continued?* A.—Until the brake cylinder pistons return to their normal release position.

622—*Q.—During this test what precaution must be observed?* A.—That the supply-line pressure does not drop below 70 lb.

623—*Q.—In case that the brake-cylinder pistons fail to return to release position, what is the probable cause?* A.—Trouble may be in the D-22-A control-valve service portion, excessive brake-rigging resistance, or trouble may be in the relay valve.

624—*Q.—How can a check be made to determine if the control valve is at fault?* A.—During the release

(*Continued on next left-hand page*)

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Photo Courtesy Southern Pacific Company

With the increase of carloadings and the constant demand on the part of shippers for quicker deliveries, progressive railroads have found the truly economical locomotives are the new design ones. Their ability to handle heavier loads and haul them at higher speeds means a material reduction in operating expenses.

Cut your operating expenses and increase your capacity . . . with MODERN LIMA POWER.

LIMA LOCOMOTIVE WORKS LIMA LOCOMOTIVE WORKS INCORPORATED **INCORPORATED, LIMA, OHIO**

test, an exhaust of air at the exhaust port in the pipe bracket shows that the service piston and slide valves have returned to release position. A continuous blow at the exhaust port, however, indicates that the service portion should be removed for further investigation on the standard test rack.

A Versatile Railway Crane

The Atchison, Topeka & Santa Fe has recently installed a versatile piece of equipment in its Pawling & Harnischfeger Model 255 crawler crane, illustrated, which rolls around the Wichita, Kan., yards doing a variety of jobs.



Pawling & Harnischfeger Model 255 crawler crane, used for handling car wheels, applying steel car sides and other parts at railway shops

As the accompanying view shows, the crane serves as a useful tool in handling the various stocks of supplies arriving from time to time; piling pieces of equipment; sorting out materials; and placing needed parts in position for repair or rebuilding.

An unusually interesting use of the crane operation is found in connection with rebuilding the line's rolling stock, a considerable proportion of which consists of steel freight cars. In assembling these cars, the crane is utilized to raise the steel car sides and hold them in position for assembly. When a car is assembled, the crane loads it.

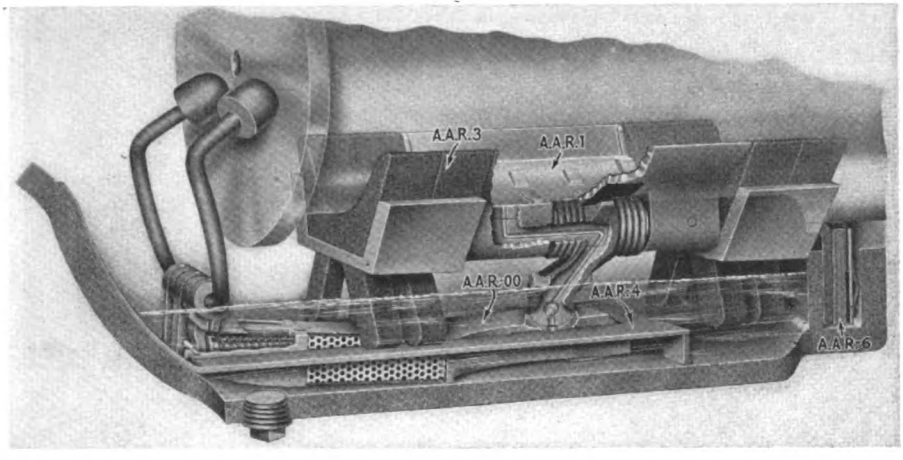
This crane maneuvers on tractor-type crawlers and should not be confused with the standard railway crane which runs on tracks. With the crawlers, the crane can travel anywhere around the yard as well as along sidings. The machine thus accomplishes a great deal of the company's loading and general handling jobs with a considerable saving in time and labor.

Mechanical Lubricator For A. A. R. Journals

The Hennessy Lubricator Co., New York, has developed a mechanical journal lubricator for use in A. A. R. journal boxes of all sizes, which can be applied without any change in the box, journal, or bearing. It can be applied or removed without removing the box from the journal. Its design permits the removal and application of the bearing without disturbing the lubricator. This lubricator dispenses with the use of waste and thereby eliminates the possibility of waste grab, allows the use of a heavier lubricant than car oil, and assures positive delivery of an ample supply of lubricant to the journal by mechanical action.

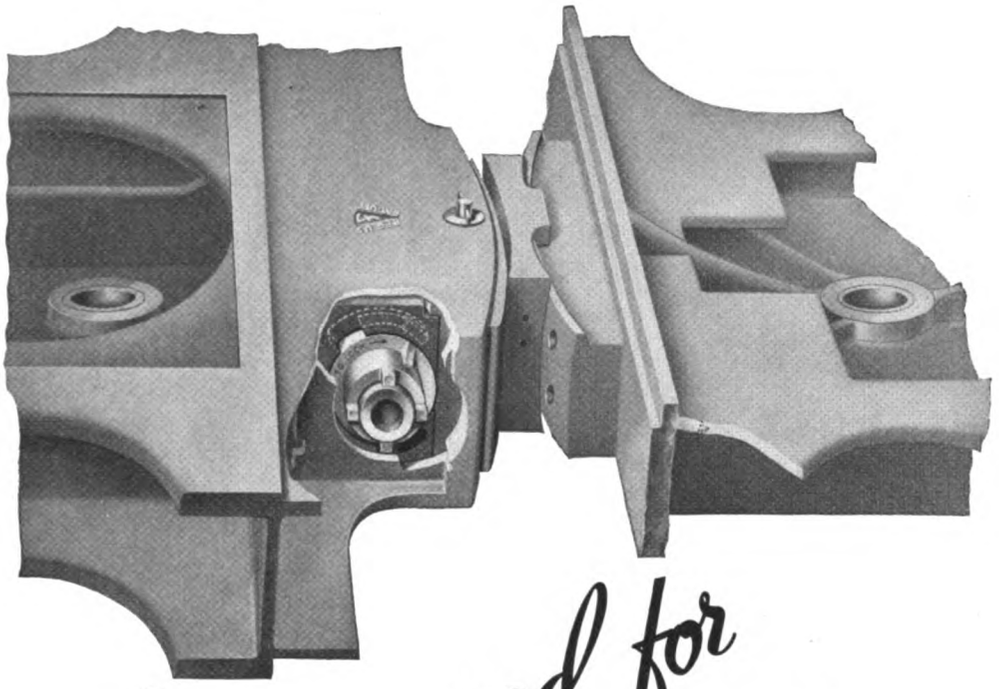
The delivery of oil to journals by capillarity when employing waste, the conventional method, requires the use of a low-viscosity oil. This means that the proper lubricant from the standpoint of viscosity for journals carrying loads such as those to which A. A. R. journals are subjected cannot be used at all times. The oil of lower viscosity delivered in this manner does not afford sufficient lubrication under certain conditions. This results in high operating temperatures which, in turn, causes the waste or other material through which the oil is fed by capillarity to become glazed or hardened with a relatively small amount of service. This may result in excessive wear and hot boxes.

The A. A. R.-type lubricator shown in the illustration is similar in operation to previous lubricators built by this company. The pump, A. A. R.-00, is actuated by the lateral movement of the journal, and forces the lubricant up to the distributor, A. A. R.-1. The felt pad, A. A. R.-3, is employed primarily to give warning in the event the journal heats in service.



The Hennessy A. A. R.-type mechanical lubricator can be applied without any change in the box, journal, or bearing and without removing the box from the journal

(Turn to next left-hand page)



"Engineered for Easy riding"

The Type E-2 Radial Buffer makes a safer, easier riding locomotive. » » » Its spherical and cylindrical faces permit movement in any direction, while its predetermined frictional resistance dampens oscillation between engine and tender, prevents lost motion and subsequent destructive shocks to drawbar and pins. » » » Its twin, the Franklin Automatic Compensator and Snubber, takes the job of maintaining proper driving box adjustment that further improves smoothness of operation and extends locomotive mileage and reduces maintenance costs. It is particularly essential on roller bearing boxes.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

High Spots in

Railway Affairs . . .

A. A. R. Pulls a Stunt

The annual meetings of the Association of American Railroads and its predecessors have always been closed to the public. It was therefore a distinct surprise to learn a few weeks ago that most of the sessions on November 13 and 14 would be open to the public. The speakers—several from outside the more intimate railroad family—were invited to speak frankly and they did not pull their punches. No attempt was made to whitewash the railroads and constructive criticism was the order of the day. This open-minded attitude on the part of the railroads made a distinct impression upon the visitors who attended the meetings and this was also reflected in the press reports. The experiment proved so successful, from all points of view, that it appears quite likely that it will be a feature of future meetings.

A Bit of Sound Philosophy

"I like to think of a railroad," said E. E. Norris, president of the Southern Railway, "not as an aggregate of inanimate locomotives and cars and tracks and buildings, but as a virile army of men and women working together to provide an essential service. I like to think of a railroad in terms of human activity, rather than in terms of physical property. For there would be no railroad plant to begin with, had it not been for the dreams, the courage, the skill, and the labor of millions of human beings. Nor could all the locomotives and cars in the world turn a wheel without co-ordinated human effort, ranging all the way from the mental work of planning and direction to the physical work of actual operation and maintenance. Fundamentally therefore the railroad is a human thing. From this concept of a railroad stems the thought that the improvement of railroad service must concern, first of all, the men and women who comprise the railroad family. That means the fellows at the top, those at the bottom, and all those in between. That means that the starting point for improvement in railroad service must lie in the minds of railroad people—in their attitudes; their mental processes; and their resulting actions. That means that if we really want to improve railroad services we've first got to improve our will and our capacity to please." Near the close of Mr. Norris' address, which was made at the annual meeting of the Association of American Railroads, he said, "in my opinion we must begin the improvement of our services at home; by erasing the last trace of the monopoly-mind from our thinking and our actions; and by inspiring, in its stead, that priceless thing — genuine friendliness — which warms the heart of both the giver and the receiver. It can be done. It is being done."

What Research Has Done for Passenger Service

"The performance of the present quality of passenger service at a lower rate than in 1916, notwithstanding greatly increased costs, is truly a modern miracle resulting from continual research," said C. E. Smith, vice-president of the New York, New Haven & Hartford, in an address on Railroads and Research before the annual meeting of the Association of American Railroads. "Comparing passenger service now rendered at a basic rate of two cents per mile, with the period when it was formerly rendered at two cents per mile," said Mr. Smith, "we find the passenger cars which then cost $8,000 each now cost from $40,000 to $70,000 each. Locomotives which cost then $15,000 to $20,000 now cost $100,000 to $500,000; wages have more than doubled, from an average of 28.3 cents per hour in 1916 to over 75 cents per hour in 1939; from an average of $891.61 annual wage in 1916 to $1,886.59 in 1939; trains are operated at greatly increased speeds with greater safety and with much greater comfort. The average revenue per passenger-mile in 1916 was 2.042 cents, as compared to 1.839 cents in 1939. In 1916 passenger cars were poorly lighted and heated and lacking in convenience and comfort. Today, as a result of continuous research we have de luxe, all-metal cars, well lighted, with temperature and air controlled winter and summer, and with more convenience and comfort than most modern homes."

Shippers Proud Of Railroads

J. E. Bryan, president of the National Industrial Traffic League, in speaking from the shippers' point of view at the meeting of the Association of American Railroads, frankly declared that "the shippers as a whole are proud of their railroad systems." While the shippers may oppose the railroads in the matter of rates, rules and regulations, they realize that they are still largely dependent upon them for the successful operation of their own business. Mr. Bryan suggested that instead of attempting to build from the top down, the railroads should build from the bottom up, by trying to get back the less-than-carload traffic through the medium of better service. "Frankly," he said, "I do not believe that there has been enough concerted effort on the part of the carriers to take back that merchandise traffic, most of which goes at the higher class rates and is remunerative." He felt also that "special attention should be given to branch line service. There is a wealth of it available," he said. "The Diesel engine, with its rubber tires, for auxiliary service of some kind, should be added to bring that tonnage down to the main line of the railroad and expedite it to the terminals and out again to wherever it belongs."

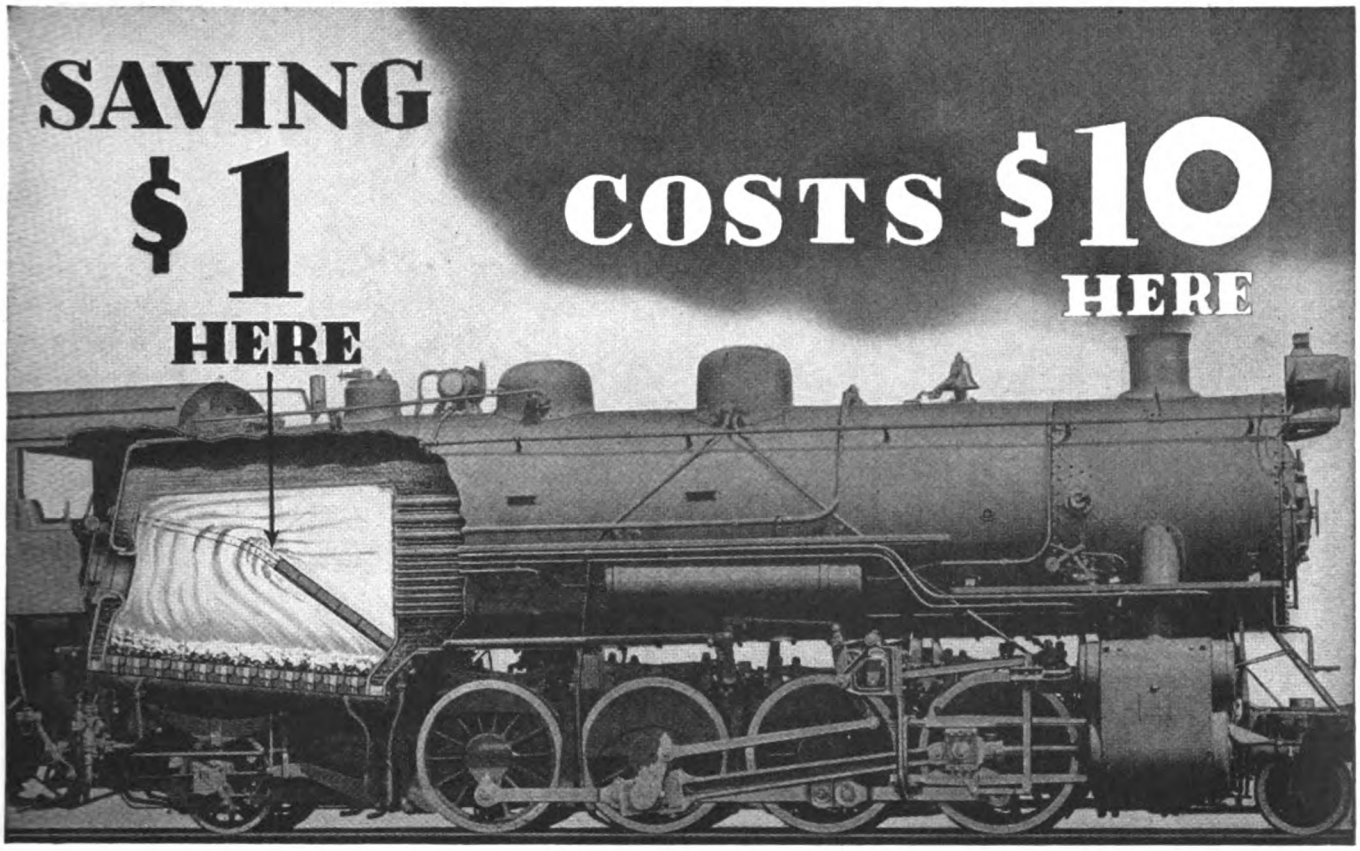
How to Make Railroad Jobs

"If the responsible heads of the Railroad Brotherhoods will call a truce on all efforts to create unwarranted jobs and working conditions and will unite with management in a concerted and vigorous effort not only to retain to the rails the traffic which now moves over them, but, as well, to get their full share of any expansion of business, they will undoubtedly be doing more to create additional jobs and heavier pay envelopes than can be accomplished in any other way." This is a rather long sentence, but it surely contains a world of truth. Moreover, it is of special importance in this country at this time, when we must put forth every effort in building up our national defense program and at the same time take care of the needs of our people. The quotation is taken from an address made by Jacob Aronson, vice-president, law, New York Central System, at the recent annual meeting of the Association of American Railroads.

The Heart of The Railroad Plant

In speaking from the viewpoint of an operating man at the meeting of the Association of American Railroads on November 14, R. H. Smith, vice-president and general manager of the Norfolk & Western, pointed out the really remarkable improvement that has been made in the railroad plant during the past two decades. "The heart of the railroad plant," he said, "is the locomotive, and that properly is where the great improvement has been made. The 1939 locomotive was stronger in drawbar pull than the 1920 engine and was also speedier. The 1939 freight train, in addition to being heavier than the 1920 train, was run faster, so that for each hour of road work, the present-day locomotive is developing twice the transportation service of its 1920 counterpart." This record, he pointed out, is made in spite of the fact that some of the older locomotives are still retained in service. "The 1939 locomotive, with its much greater availability and working hours," he said, "is developing several times the actual transportation of its 1920 predecessor and it is doing this much cheaper, in spite of rising wage costs."

(*Turn to next left-hand page*)



cut down on the arch and you boost the fuel bill

No one questions locomotive Arch economy. The Arch has been so thoroughly proved as a fuel saver by railroad after railroad for years past.

In the urge for money saving don't let the desire to save a few dollars in Arch brick expense by skimping on the Arch blind you to the fact that every dollar thus "saved", boosts the fuel bill ten dollars.

The surest way to the lowest operating cost is not in crippling proved economy devices but in making full use of them. This means complete Arches, with every brick in place, for each locomotive that leaves the roundhouse.

HARBISON-WALKER REFRACTORIES CO.

Refractory Specialists



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Locomotive Combustion Specialists

Among the Clubs and Associations

RAILWAY CLUB OF PITTSBURGH.—Meeting held on November 21 at Fort Pitt Hotel, Pittsburgh, Pa. Speaker: A. F. Stuebing, development engineer, Carnegie-Illinois Steel Corporation. Subject: High-Tensile Steels in Railroad Service, supplemented by moving pictures, "Making and Shaping of Steel."

NORTHWEST LOCOMOTIVE ASSOCIATION.—Meeting 8 p. m., December 16, at Woodruff Hall, St. Paul, Minn. Speaker: L. E. Caldwell, service education director, Electro-Motive Corporation. Subject: Modern Diesel Locomotives, with motion pictures entitled "EMC Railway Type Diesel Engines" and "Diesels Working on the Railroads."

NEW YORK RAILROAD CLUB.—Sixty-eighth anniversary dinner, Commodore hotel, New York, Thursday, December 12, at 7 p. m. W. E. Corrigan, vice-president American Locomotive Company, New York, is general chairman. Reservations should be placed with C. C. Fletcher, chairman, seating committee, Room 1462, 460 Lexington Ave., New York, by December 2.

PURCHASES AND STORES DIVISION, A. A. R.—Twenty-three committees with approximately 180 members have been selected to prepare reports for the next annual convention of the Purchases and Stores division, A. A. R. These committees are exclusive of the General, Advisory and Special Purchasing committees of the Division and its regional purchasing and stores committees. One new committee has been formed to study Diesel-engine parts, and committee work on highway vehicles, shop-made materials, fire and safety and terminal railway storekeeping has been revised. The personnel of the new standing committees includes 4 new chairmen and 17 new members. A. C. Mann, vice-president, Illinois Central, is chairman of the Division.

Some of the subject committees and their chairmen are as follows:

Purchasing and Stores Manual: P. L. Grammer, assistant purchasing agent, Penna.
Material Classification: E. G. Roberts, general storekeeper, C. R. I. & P.
Railroad Scrap: R. E. Hamilton, supervisor reclamation, C. & O.
General Reclamation (Joint with Mechanical and Engineering Divisions): E. R. Casey, superintendent of reclamation, U. P.
Shop Made Materials: G. D. Tombs, division storekeeper, I. C.
Fuel: P. A. Hollar, fuel purchasing agent, Penna.
Fire and Safety: H. J. Blum, general storekeeper, M-K-T.
Handling Facilities: S. P. Warmack, general storekeeper, I.-G. N.
Simplification and Standardization: A. G. Follette, general material supervisor, Penna.
Stores Practices and Records: J. S. Genther, general storekeeper, L. & N. E.
Marking Tools, Materials, Etc.: W. H. Lloyd, division storekeeper, C. R. I. & P.
Diesel Engine Parts: O. L. Browne, assistant to purchasing agent, A. C. L.

NEW ENGLAND RAILROAD CLUB.—Meeting December 11 (one day later than regular meeting) at Hotel Touraine, Boston, Mass. Address by Joseph B. Eastman, chairman, Interstate Commerce Commission. Meeting starts with dinner at 6:30 p. m.

COMMITTEE OF THE COORDINATED ASSOCIATIONS.—At a meeting of the Committee of the Coordinated Associations at the close of the annual meetings of the Railway Fuel and Traveling Engineers' Association, the Master Boiler Makers' Association, the Car Department Officers' Association, and the Locomotive Maintenance Officers' Association, and the exhibit of the Allied Railway Supply Association, the dates for next year's simultaneous meetings were established as September 22, 23, and 24, 1941. They will be held without the exhibit.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

AIR BRAKE ASSOCIATION.—R. P. Ives, Westinghouse Air Brake Company, 3400 Empire State building, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION. — J. F. Gettrust, P. O. Box 5522, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. —C. E. Davies, 29 West Thirty-ninth street, New York.
RAILROAD DIVISION.—C. L. Combes, *Railway Mechanical Engineer,* 30 Church street, New York City.
MACHINE SHOP PRACTICE DIVISION.—Warner Seely, Warner & Swasey Co., 5701 Carnegie avenue, Cleveland, Ohio.
MATERIALS HANDLING DIVISION. — F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.
OIL AND GAS POWER DIVISION. — W. J. Hargest, American Machinst, 330 West Forty-second street, New York.
FUELS DIVISION.—A. R. Mumford, Consolidated Edison Co., 4 Irving Place, New York.

ASSOCIATION OF AMERICAN RAILROADS.—Charles H. Buford, vice-president Operations and Maintenance Department, Transportation Building, Washington, D. C.
OPERATING SECTION. — J. C. Caviston, 30 Vesey street, New York.
MECHANICAL DIVISION.—V. R. Hawthorne, 59 East Van Buren street, Chicago.
PURCHASES AND STORES DIVISION.—W. J. Farrell, 30 Vesey street, New York.
MOTOR TRANSPORT DIVISION. — George M. Campbell, Transportation Building, Washington, D. C.

CANADIAN RAILWAY CLUB. — C. R. Crook, 4415 Marcil avenue, N. D. G., Montreal, Que. regular meetings, second Monday of each month, except June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT ASSOCIATION OF ST. LOUIS. — J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, DeSoto Hotel, St. Louis, Mo.

CAR DEPARTMENT OFFICERS' ASSOCIATION.—Frank Kartheiser, chief clerk, Mechanical Dept., C. B. & Q., Chicago. Annual meeting September 22, 23 and 24, 1941.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 8238 S. Campbell avenue, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month.

CENTRAL RAILWAY CLUB OF BUFFALO.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday of each month, except June, July and August, at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION. — Roy MacLeod, Room 127, General Office Bldg., N. Y., N. H. & H., New Haven, Conn. Regular meetings, second Friday of January, February, March, April and October at Engineering Societies Bldg., 29 West Thirty-ninth street, New York.

INDIANAPOLIS CAR INSPECTION ASSOCIATION. — R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, in Indianapolis Union Station, Indianapolis, at 7 p. m.

INTERNATIONAL RAILWAY FUEL ASSOCIATION. — See Railway Fuel and Traveling Engineers' Association.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—See Locomotive Maintenance Officers' Association.

LOCOMOTIVE MAINTENANCE OFFICERS' ASSOCIATION.—J. E. Goodwin, general foreman, locomotive department Missouri Pacific, North Little Rock, Ark. Meeting September 22, 23 and 24, 1941.

MASTER BOILER MAKERS' ASSOCIATION. — A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y. Annual meeting September 22, 23 and 24, 1941.

NEW ENGLAND RAILROAD CLUB. — W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Thursday in each month, except June, July, August, September and December at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION. — E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, 1931 University avenue, St. Paul.

NORTHWEST LOCOMOTIVE ASSOCIATION. — G. F. Greenleaf, chief clerk to mechanical engineer, Northern Pacific, St. Paul, Minn. Meeting last Monday of each month, except June, July and August.

PACIFIC RAILWAY CLUB. — William S. Wollner, P. O. Box 3275, San Francisco, Cal. Monthly meetings alternately in northern and southern California.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1647 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

RAILWAY FUEL AND TRAVELING ENGINEERS' ASSOCIATION.—T. Duff Smith, Room 811, Utilities building, 327 South La Salle street, Chicago. Annual meeting, September 22, 23 and 24, 1941.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION. —J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

TORONTO RAILWAY CLUB.—D. M. George, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto, Ont.

TRAVELING ENGINEERS' ASSOCIATION.—See Railway Fuel and Traveling Engineers' Association.

VALLEY ANTHRACITE CAR FOREMEN'S ASSN.—Exec. sec., Walter B. Riggin, 215 Swartz st., Dunmore, Pa. Meets third Monday of each month at Wilkes-Barre, Pa.

WESTERN RAILWAY CLUB.—W. L. Fox, executive secretary, Room 822, 310 South Michigan avenue, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

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THERE GO 2000 MORE STEEL WHEELS!



HERE are the first of 250 new freight cars recently placed in service by the Denver and Rio Grande Western. These cars, of 50-ton capacity, are modern in every respect, built with U·S·S COR-TEN, and equipped for low-cost, long-mileage operation with U·S·S One-Wear Wrought Steel Wheels.

Started only a few years ago, the trend toward steel wheels is rapidly assuming the proportions of a landslide. More than a million one-wear steel wheels are in service today—and every day the number is increasing. New freight cars are rolling out of the shops on steel wheels. Railroads and private car-line operators are replacing defective wheels with steel.

Why? Because the steel wheel offers longer mileage, lower service costs, lighter weight, and greater safety. Experience has proved these advantages so convincingly that no railroad can afford to overlook them. Send today for data.

Don't pass up these Savings

1. LONG MILEAGE. Mileages up to 300,000 miles have been recorded for one-wear steel wheels. Conservatively, this wheel generally averages at least 180,000 miles under 50/55 ton equipment.

2. LOW COST. Years of actual service with these wheels prove they cost less, per thousand miles, than any other type of freight car wheel.

3. SAVE WEIGHT. These wheels save 1400 pounds per car, adding extra lading capacity, reducing unsprung weight 12%, reducing roadway depreciation.

4. GREATER SAFETY. A.A.R. records prove that derailments and delays due to wheels decline sharply wherever steel wheels are used.

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh — *Chicago*

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* — United States Steel Export Company, New York

UNITED STATES STEEL

NEWS

Boiler Explosion on F.E.C. Causes Death of Head-End Crew

EXPLOSION of the boiler of the locomotive hauling Florida East Coast passenger train No. 34, the northbound "Tamiami," four miles south of New Smyrna Beach, Fla., late on October 25, caused the derailment of the locomotive in which the fireman and engineman sustained injuries resulting later in death. No passengers suffered serious injuries. Investigation developed that the explosion was due to low water.

A. A. R. Holds First Open Meeting

OVER 800 persons, including railroad officers, traffic managers, and representatives of industry, agriculture and labor, gathered at the Biltmore Hotel, New York, on November 13 and 14, for the first open meeting ever held by the Association of American Railroads. Distinguished leaders in finance, government, agriculture and industrial traffic management discussed railroad questions from their respective points of view at the open session on Wednesday morning, November 13, and at the banquet in the evening, while on Thursday morning a panel of representatives of shippers, labor and carriers held a symposium on railroad service and how it may be further improved.

The annual dinner of the Railway Business Association on Thursday evening afforded an opportunity for another get-together of many of those who had attended the A. A. R. meeting. Because of the open meeting of the A. A. R., there were no addresses at the R. B. A. dinner.

Car Service Division Report

THE increase in serviceable equipment as compared with last year and the continuing cooperation of shippers in the matter of efficient car utilization are expected by the Car Service Division to result in a meeting of this fall's equipment needs satisfactorily. This assurance is given in the Division's annual report which is now being distributed.

In another place the report lays considerable stress on the economies which come from heavier loading of cars. The new high mark of 36.8 tons set in 1939 as the average tons per car of carload freight is cited; and the report goes on to observe that if the average load last year had remained at the 1938 level "it would have required 652,000 more car loads to have handled the traffic." Moreover the improved loading during the October, 1939, peak "was equivalent to adding 20,000 cars to the equipment supply without capital cost." The report added: "Perhaps no single factor today—with all operating procedure under studied control—presents so definite an opportunity for reduction in expense as does this item of heavier loading."

The report recalls how the Division's Troop Movement Section was reorganized on August 1 as the Military Transportation Section with enlarged duties and an increase in personnel. During the year ended September 1, the Military Transportation Section furnished routings for the movement of more than a quarter of a million men for the army, navy, marine corps and C. C. C., exclusive of the men handled in the fall maneuvers of the four armies. While there is no measure of the amount of revenue returned to the carriers as a result of movements of the military, the railroads have thus far earned a gross of $120,998,000 from C. C. C. freight and passenger movements.

The discussion of the automobile car situation points out that "the number of machines delivered overland and shipped by boat accounted for 61.6 per cent of the 1939 United States production, which was the largest proportion of the production handled by these agencies during any calendar year on record." Meanwhile "there has been no shortage of device-equipped automobile cars for the handling of all the commercial shipments offered by the industry." Nor has there been any difficulty in taking care of all requirements for refrigerator cars.

Lehigh Valley Apprentices Honored

AN unusual event took place on the Lehigh Valley at Sayre, Pa., on Saturday evening, November 2. The great Shops Assembly Hall was filled with almost 1,200 people, who participated in a banquet and entertainment given by the Sayre System Shop Athletic Association in honor of the 119 Lehigh Valley Shop apprentices. The toastmaster was Harry J. Farr, and the principal address was made by President A. N. Williams of the Lehigh Valley, who was introduced by Dr. Donald Guthrie, the chief surgeon of the road. President Williams commended the good work being done by the apprentices. He also discussed certain phases of the national defense program which involve carrier co-operation. Short talks were also made by Dexter C. Buell of the Railway Educational Bureau; Roy V. Wright, editor of the *Railway Mechanical Engineer;* Judge R. W. Barrett, vice-president and general counsel of the Lehigh Valley; John Duffy, vice-president of traffic; and Ernest G. Smith, a member of the board of directors of the Lehigh Valley. A unique feature of the program was a series of lantern slides showing the status and school and work percentage records for a number of the more advanced apprentices. Dinner music was furnished by the Lehigh Valley System Shops Band. In addition to those mentioned, a number of other executive officers of the railroad were present.

City of Los Angeles Has Coach-Lounge

A COACH-lounge, an innovation in passenger service, has recently been added to the Streamliner City of Los Angeles of the Union Pacific-Chicago & North Western. The addition increases the consist of the train to 18 cars. The new car has 24 reclining coach seats in the forward half and an array of settees and lounge chairs upholstered in green, brown and blue in the other half. The walls and the ceilings are colored with combinations of chartreuse, gray, ivory and light cream.

Budd Analysis of Florida Streamliner Business

SUPPLEMENTING an analysis of the possibilities of streamline trains throughout the country published last Spring, the Edward G. Budd Manufacturing Company has issued a 100-page volume of the same character describing the operations and traffic results of streamliners to and within Florida which the Seaboard Air Line, Atlantic Coast Line and Florida East Coast have placed in service since February, 1939.

For each of the three railroads there is presented a brief pictorial history, scenes of the new passenger equipment and of inaugural celebrations and a complete set of floor plans.

Locomotive Orders—A Correction

FOOTNOTE 3 in the table of Orders and Inquiries for New Equipment on page 426 of the October, 1940, issue applies to two orders. The eight locomotives purchased by the D. M. & I. R. from the Baldwin Locomotive Works have a total value of approximately $2,000,000. The Seaboard Air Line 2,000-hp. Diesel-electric locomotive which was on display at the New York World's Fair this year is for use with the Silver Meteor equipment between New York and Florida.

Book on Railways and Supply Industry Prepared by R. B. A.

A NEW book, Railways and the Equipment and Supply Industry was prepared by the Railway Business Association, Chicago, for its annual meeting at New York on November 14. The 100-page brochure is a compilation of historical and other

data relating to the facilities and equipment used on the railways. The subjects include Roadbed, Tunnels and Bridges; Rails and Signals; The American Locomotive; The Car Builders; and The Railway and the Laboratory. A list of officers and members of the R. B. A. is also included.

The book is written "as a tribute to all the scientists, inventors and engineers who have had a share in creating a great transportation machine and to others who have built an important industry whose laboratories and plants produce and assemble the thousands of parts from which this machine is constructed."

In the various chapters of the book it is pointed out that the coming years promise to see the emergence of the type of locomotive power which can do the work best and cheapest, and as to speeds, the limiting factors now are the track and the roadbed rather than the type—Diesel or steam.

Improvements in railway travel and in the handling of the freight traffic of American railways are due just as much to the progressive adaptation of the vehicle to the changing requirements of today as to the constantly increasing improvements in the track and in the motive power.

While distinct and separate capital investment exists as between the railways and the railway equipment and supply industry, there is an indissoluble partnership that binds together these two fields of American private enterprise in the common interest of the public and in the perfection of the rail transport machine.

Equipment Purchasing and Modernization Programs

Atchison, Topeka & Santa Fe.—The Santa Fe has asked the Interstate Commerce Commission for authority to assume liability for $10,000,000 of 1¼ per cent equipment trust certificates, maturing serially in the sum of $1,000,000 on December 5, 1941, and a like amount annually thereafter, until and including December 5, 1950. The proceeds will constitute 80 per cent of the purchase price of new equipment costing a total of $12,500,000 and consisting of 2,000 50-ton box cars; 300 70-ton ballast cars; 200 50-ton low-side gondola cars; 50 70-ton low-side gondola cars; one baggage car; one baggage-mail car; 14 chair cars, one lunch-counter diner; two club lounge cars; one chair observation car; eight oil-burning passenger steam locomotives without tenders, with conventional main and side rods; two oil-burning passenger steam locomotives without tenders, with main and side rods of high dynamic steel and side rods, equipped with roller bearings on all crank pins; 10 locomotive tenders, and three Diesel-electric locomotives of 2,000 hp. each.

Bessemer & Lake Erie.—The B. & L. E. has asked the Interstate Commerce Commission for authority to assume liability for $4,000,000 of equipment trust certificates, maturing in 10 equal annual installments of $400,000 on December 16, in each of the years from 1941 to 1950, inclusive. The proceeds will constitute a

(*Continued on second left-hand page*)

Orders and Inquiries for New Equipment Placed Since the Closing of the November Issue

Locomotive Orders

Road	No. of Locos.	Type of Locos.	Builder
Atchison, Topeka & Santa Fe	1	4,000-hp. Diesel-elec	Electro-Motive Corp.
	1	4,000-hp. Diesel-elec	American Loco. Co.
Brazilian and Bolivian Govt's	4	Mogul type	Vulcan Iron Works
Chicago, Rock Island and Pacific	2[1]	2,000-hp. Diesel-elec.	American Loco. Co.
	2[1]	1,000-hp. Diesel-elec.	
Florida East Coast	1	2,000-hp. Diesel-elec.	Electro-Motive Corp.
Kansas City Terminal	2	1,000-hp. Diesel-elec.	American Loco. Co.
	1	660-hp. Diesel-elec.	
Ministry of Transp. and Public Works, Brazil	13	2-8-2	American Loco. Co.
	10	2-8-2	Baldwin Loco. Works
	3	2-6-6-2	
Newburgh & South Shore	1[2]	1,000-hp. Diesel-elec.	American Loco. Co.
Spokane, Portland & Seattle	2[2]	1,000-hp. Diesel-elec.	American Loco. Co.
	2[2]	1,000-hp. Diesel-elec.	Baldwin Loco. Works
Terminal Rwy., Alabama State Docks	1	0-6-0	American Loco. Co.
Union Railroad	2[2]	1,000-hp. Diesel-elec.	Baldwin Loco. Works
Wyandotte Terminal	1	300-hp. Diesel-elec.	General Electric Co.

Locomotive Inquiries

Seaboard Air Line	2	600-hp. Diesel-elec.	.....
Texas Pacific-Missouri Pacific-Terminal R. R. of New Orleans	1	660-hp. Diesel-elec.	.....

Freight-Car Orders

Road	No. of Cars	Type of Cars	Builder
Atchison, Topeka & Santa Fe	300	Ballast	Rodger Ballast Car Co.
	250	Gondola	Gen. Amer. Transp. Corp.
	200	Hopper	
	50	Flat	
	2,000	Box	Pull. Std. Car Mfg. Co.
Canadian General Transit Co., Ltd.	1[3]	Tank	Canadian Car & Fdry Co.
Chicago, West Pullman & Southern	2	50-ton gondola	Company shops
Denver & Rio Grande Western	28	Freight	Company shops
	500	50-ton box	Pressed Steel Car Co.
E. I. du Pont de Nemours & Co.	2	50-ton tank	American Car & Fdry. Co.
Electro Bleaching Gas Co.	1[3]	40-ton tank	American Car & Fdry Co.
Erie	250	Hopper	Pull. Std. Car Mfg. Co.
	250	Hopper	Gen. Amer. Transp. Corp.
	200	Box	American Car & Fdry. Co.
	100	Box	Magor Car Co.
	250	Gondola	Greenville Steel Car Co.
	100	Furniture	American Car & Fdry. Co.
Hooker Electrochemical Co.	5	40-ton tank	Gen. Amer. Transp. Corp.
Lehigh & New England	300	Hopper	Pressed Steel Car Co.
Monsanto Chemical Co.	6	50-ton tank	Gen. Amer. Transp. Corp.
	3	40-ton tank	
New York Central	1,000	50-ton box	Despatch Shops, Inc.
North Western Refrigerator Line Co.	100[2]	40-ton refrigerator	American Car & Fdry. Co.
	100[2]	50-ton refrigerator	
U. S. Army, Corps of Engineers	20	Box	Gen. Amer. Transp. Corp.
	4	Flat	Haffner-Thrall Car Co.
U. S. Navy	15	50-ton flat	American Car & Fdry. Co.
	6	Gondola	Haffner-Thrall Car Co.
	5	50-ton flat	
	3	50-ton box	
War Dept., Office of Chief Engineer	260	Tank	American Car & Fdry. Co.

Freight-Car Inquiries

Road	No. of Cars	Type of Cars	Builder
Duluth, Missabe & Iron Range	30	Ballast	.....
Elgin, Joliet & Eastern	500	Gondola	.....
	250	Hopper	.....
Erie	70	Caboose	.....
Louisville & Nashville	3,000	Hopper	.....
	100	Automobile	.....
	50	Gondola	.....
Norfolk Southern	250	40-ton box	.....
	50	50-ton hopper	.....
	50	50-ton gondola	.....
Seaboard Air Line	700	Freight	.....

Passenger-Car Orders

Road	No. of Cars	Type of Cars	Builder
Atchison, Topeka & Santa Fe	14	Chair	Edw. G. Budd Mfg. Co.
	2	Club-lounge	
	1	Chair-observation	
	1	Lunch counter diner	
	1	Mail-storage	
	1	Baggage-mail	
Chicago, North Shore & Milwaukee	8[3]	.....	St. Louis Car Co.

[1] Purchase authorized by the federal district court. Those of 2,000 hp. each will be used on the Arizona Limited, an all-Pullman streamlined train which the Rock Island and the Southern Pacific will place in service between Chicago and Phoenix, Ariz., on December 15, and those of 1,000 hp. each will be used in mixed train service on the branch line between Albert Lea, Minn., and Sioux Falls, S. D., via Estherville, Iowa.

[2] Delivery received.

[3] Two articulated passenger-trains of four units each, including coaches and tavern car.

Stellar Pe

99% Availability

SIX B.&O. DIESELS OPERATE 3,441,916 MILES IN PASSENGER SERVICE





General Motors 2-Cycle Diesel Engine

SIX 3600 Hp. EMC Diesel passenger locomotives entered service on the Baltimore and Ohio — two in May and June, 1937; two in January, 1938; two in June, 1938. Up to June 30, 1940, these locomotives have operated 3,441,916 miles with an average availability of 95.5 per cent. Diesel locomotive No. 56 on the Capitol Limited, which operated every day for an entire year without missing a trip, has to its credit 515,485 miles with 99.3 per cent availability.

Typical of EMC Diesel performance, these records are being made in fast passenger service without excessive top speeds but with high average speed consistent with safety, passenger comfort, and minimum wear on rolling stock and track. No other type of motive power can equal this performance.

ELECTRO-MOTIVE CORPORATION

B&O

Railw



NORTHWES

99.23% Availability

Six Rockets Make Records

The Rock Island's fleet of six smartly styled stainless steel streamlined "Rockets" has established an enviable performance record with the utmost in safety, comfort and economy.

The six "Rocket" locomotives, built by Electro-Motive Corporation and each powered by one General Motors 1200 horsepower two-cycle Diesel engine, entered service in the fall of 1937. The records shown are from the date of installation to January 1, 1940.

Entered Service in Fall of 1937

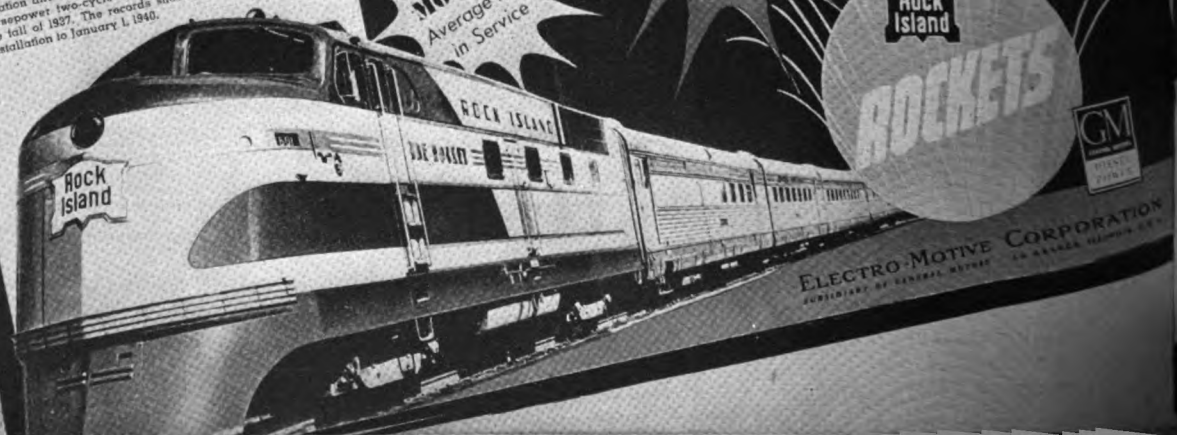
2,986,317 Total Miles Operated

99.23% Average Availability

$.08 Average Maintenance Cost per Mile

28 MONTHS Average Time in Service

112,299 Average Assigned Miles per Month



ELECTRO-MOTIVE CORPORATION
SUBSIDIARY OF GENERAL MOTORS

rformances



BACK of the name **"EMC DIESEL"** stands irrefutable evidence of superior performance. Not by one locomotive but many—not on one railroad but many.

EMC Diesel locomotives, operating in the world's fastest schedules and with highest mileages per day and year, continue to establish records for low operating costs, dependability and high availability — far above any other type of motive power.

On the Burlington fifteen EMC Diesel-powered trains operated over 10,000,000 miles with the high **availability of 97.6%.**

On the Rock Island thirteen EMC Diesel-powered Rocket locomotives operated 4,534,938 miles with an **availability record of 98.7%.**

On the Baltimore & Ohio six original EMC 3600 Hp. Diesel locomotives operated 3,441,916 miles with an **availability of 95.5%.** Locomotive No. 56 operated an entire year without missing a trip and made 515,485 miles with **99.3% availability.**

On the Chicago & Northwestern two EMC 4000 Hp. Diesel locomotives operated 758,227 miles without missing a trip in over 18 months—an **availability record of 100%.**

ELECTRO-MOTIVE CORPORATION
SUBSIDIARY OF GENERAL MOTORS LA GRANGE, ILLINOIS, U. S. A.



GM
GENERAL MOTORS
DIESEL POWER

part of the purchase price of new equipment costing a total of $5,350,000 and consisting of five 2-10-4 Texas type freight locomotives; two 0-8-0 switching locomotives; 650 90-ton hopper cars; 300 50-ton box cars (class XM-4); 100 50-ton box cars (class XM-3); 50 50-ton flat cars, and 20 all-steel caboose cars.

Erie.—The Erie has asked authority from the Interstate Commerce Commission to assume liability for $3,000,000 of equipment trust certificates, maturing in the amount of $150,000 on June 1, 1941, and $150,000 on December 1, 1941, and a like amount semi-annually on June 1 and December 1, in each year thereafter to and including December 1, 1950. The proceeds will be used as part payment for equipment costing a total of $3,410,000 and consisting of 500 50-ton hopper cars; 250 70-ton drop end gondola cars; 300 50-ton box cars; 100 50-ton furniture cars; and 50 70-ton flat cars.

Illinois Central.—The Illinois Central has undertaken a locomotive-rebuilding and modernization program at a cost of $4,449,900. Of this amount, $2,003,400 is for the modernization and repair of 84 locomotives of the 2-10-2 type. Twenty-five of these have been completed and the balance have been scheduled for this year and next. A total of $883,500 is to go for the modernization of 31 locomotives of the 2-8-4 type, of which 21 have been completed and 12 are scheduled for 1941. A total of $487,500 is allotted for the modernization of 25 Mikado type locomotives, of which one is completed. A total of $295,500 is to go for the assembly of parts into 15 locomotives of the 2-10-0 type, of which 14 have been completed. A total of $780,000 is for the conversion of 13 locomotives, the work on which has already been completed.

Lehigh & New England.—The L. & N. E. has asked the Interstate Commerce Commission for authority to assume liability for $640,000 of 1⅞ per cent equipment trust certificates, maturing in 10 annual installments of $64,000 on December 15, in each of the years from 1941 to 1950. The proceeds will constitute a part of the purchase price of 300 all-steel hopper cars costing a total of $712,500.

Southern.—The Southern has asked the Interstate Commerce Commission for authority to assume liability for $3,000,000 of 1⅞ per cent equipment trust certificates, maturing in 10 annual installments of $300,000 each on December 1 of each of the years from 1941 to 1950, inclusive. The proceeds will constitute 80 per cent of the purchase price of equipment costing $3,750,000 and consisting of five Diesel-electric locomotives, six passenger-baggage cars, 21 coaches, five dining cars, six lounge-tavern cars, four mail-baggage cars, and two mail-storage cars. The new equipment will be used to inaugurate two new all-coach trains, one from New York City to New Orleans, and one from Washington, D. C., to Memphis.

Wabash.—The Wabash, according to company officers, is contemplating expenditure during the next 5 years of approximately $8,000,000 for new equipment which will include 1,800 freight cars, 3 steam locomotives, 15 Diesel-electric switching locomotives and an undetermined number of passenger cars.

AFL RR Unions Continue to Progress

THE Railway Employees' Department, American Federation of Labor, and its affiliated international organizations "have continued to make progress in their various activities during the past year," according to the report of the Federation's executive council which was submitted to the sixtieth annual convention in New Orleans, La., during the week beginning November 18.

The report deals first with the progress of organization work and then with railroad employment. "From the standpoint of personnel," it says in the latter connection, "the railroad industry is prepared to meet any demands upon it, including those of the national defense program, which incidentally has not yet had any appreciable influence on the railroad industry." It is suggested that additional job opportunities for railroaders will be offered when the program is fully underway; but "it should be made clear that the supply of skilled workmen in the railroad industry is ample to meet the needs of that industry, and consequently there will be no need to break down the apprenticeship program or the working conditions which have been established in the railroad industry after many years of effort, under the pretense that this is necessary for national defense."

After having next discussed general transportation legislation, the report came to its section on the vacations-with-pay demand, in which it is pointed out that because of regional difficulties a national conference committee has not yet been formed. In the railroad industry, the report goes on, "paid vacations are still restricted to the executive and supervisory forces and in some instances to clerical workers, but with respect to the latter group vacations are granted only if it can be done without expense to the company. The railroad industry, therefore, which profits the most from a general vacation policy in industry through increased passenger traffic, has perhaps been the most backward in granting vacations with pay to its own employees."

Meanwhile, during the previous week, B. M. Jewell, president of the Railway Employees' Department, addressed to the general chairmen of the Department's affiliates a communication calling for utilization of railroad plants and personnel to the fullest possible extent in the national defense program. By following such a policy, Mr. Jewell said, the government would save money and at the same time avoid delays involved in building new plants and in training workers. "The railroad industry," he went on, "has large plant and facility capacity and in these times, particularly, should do all its own repair work and all its new building within its own plants, with its own facilities, and with its own employees. If there are any excess railroad plants or facilities or employees they should be made available to and engaged as promptly as possible in other national defense work."

Supply Trade Notes

R. S. CLINGAN, formerly of the Republic Steel Corporation, has been appointed Chicago district manager of the Copperweld Steel Company, Warren, Ohio.

◆

WILLIAM M. LEIGHTON, who has represented The Oxweld Railroad Service Company in the Southeastern territory for the past several years, will retire on December 31, 1940.

◆

HENRY H. TIMKEN, JR., vice-president and general manager of the steel and tube division of the Timken Roller Bearing Company, Canton, Ohio, has also been elected chairman of the board to succeed his father, Henry H. Timken, Sr., deceased.

THE AMERICAN CAR & FOUNDRY COMPANY has awarded a contract to the L. O. Stocker Company for the construction of a one-story 50 ft. by 50 ft. brick addition to its car-building plant at St. Louis, Mo.

◆

EARL G. MORGAN, formerly a district representative of the Vilter Manufacturing Company, has joined the air conditioning and refrigeration division of the Worthington Pump & Machinery Corporation as sales representative with headquarters at company's Kansas City, Mo., office.

◆

GEORGE A. BLACKMORE, president of the Westinghouse Air Brake Company since 1936, has been elected by the board of directors to fill the additional office of chairman of the board, succeeding Charles A. Rowan, deceased.

◆

WILLIAM HARTY, chairman of the board of the Canadian Locomotive Company, Ltd., of Kingston, Ont., has been elected a director of the Canadian Car and Foundry Company, Ltd., of Montreal, Quebec.

◆

THE INLAND STEEL COMPANY, Chicago, has opened a district sales office at 40 Wall street, New York, to handle export and domestic business in the eastern territory. Powell Pardee, special representative at New York, has been appointed district sales manager.

W. M. BLACK, vice-president of the American Manganese Steel division of the American Brake Shoe & Foundry Co., with headquarters at Chicago Heights, Ill., has been elected president with the same headquarters. W. E. Crocombe, who formerly headed the American Manganese Steel division, continues as president of the American Forge division. Mr. Black has been with American Manganese since 1912, with the exception of the war years when he served as a lieutenant in the ordnance department of the United States army. He was appointed general sales manager in 1934 and was elected vice-president in 1935.

◆

MARVEL EQUIPMENT CORPORATION, Chicago, has moved its sales office from its factory to 224 South Michigan avenue, Chicago.

◆

L. H. GILLICK, assistant to the vice-president of the Vapor Car Heating Company, Inc., Chicago, has been appointed sales manager. Mr. Gillick was born at Minneapolis, Minn., on August 25, 1898. After attending Northwestern University he entered the employ of the Chicago Car Heating Company, predecessor of the Vapor Car Heating Company, Inc., in January, 1916. After completing a period of training in the shops he was appointed inspector in the Chicago district. On September 1, 1920, he became Northwest representative of sales and service, with headquarters at St. Paul, Minn. In November, 1925, he was promoted to the position of assistant to the vice-president at Chicago.



L. H. Gillick

◆

FRANK H. CUNNINGHAM, who has been associated with the Graham-White Sander Corporation as sales manager, has been appointed vice-president in charge of sales. Mr. Cunningham was formerly with the Norfolk & Western, Standard Stoker Company and Franklin Railway Supply Company.

◆

RANDOLPH B. COOKE, JR., has been appointed southeastern representative of the Gold Car Heating and Lighting Company, with offices in the Royster Building, Norfolk, Va.

Personal Mention

General

W. H. SCHULTZ, assistant master mechanic on the Chicago & North Western at Clinton, Iowa, has been appointed superintendent of motive power of the Lake Superior & Ishpeming, with headquarters at Marquette, Mich.

Master Mechanics Road Foreman

F. B. CLARK, general foreman locomotive department of the Seaboard Air Line at Jacksonville, Fla., has been appointed master mechanic of the North Florida division, with headquarters at Jacksonville.

JOHN F. RYAN, who has been appointed master mechanic of the Louisville & Nashville at Ravenna, Ky., as noted in the November issue, was born on April 18, 1893, at Russellville, Ky. He attended St. Mary's College, St. Marys, Ky., from 1906 until 1909, entering the service of the Louisville and Nashville on January 1, 1910, as an apprentice, first at Russellville, and two years later at the South Louisville shop. He was a machinist and fireman on the O. & N. division from 1914 until 1917, then lead machinist at Ravenna until 1918, when he entered the army, being commissioned a lieutenant at Camp Gordon, Ga. He returned to Ravenna in 1919 as enginehouse foreman, becoming general foreman there in 1927 and master mechanic on September 1, 1940.



John F. Ryan

FRANK W. TAYLOR, general shop foreman on the St. Paul division of the Northern Pacific, has been appointed master mechanic of the Yellowstone division, with headquarters at Glendive, Mont., succeeding F. J. Regan, deceased.

G. W. GILLELAND, master mechanic of the North Florida division of the Seaboard Air Line, has been transferred to the Virginia division, with headquarters at Richmond, Va.

Obituary

ORA CLAIR MONTGOMERY, assistant superintendent of power of the New York Central at New York, died suddenly on November 10 from a heart attack, at the age of 56 years.

Trade Publications

CARBOLOY TOOLS.—Carboloy Company, Inc., Detroit, Mich. Engineering Bulletin GT-123, "Machining Steel with Carboloy Tools," with supplement of data for machining cast iron, non-ferrous metals and non-metallic materials.

◆

MUNITIONS THREADING.—Landis Machine Company, Waynesboro, Pa.—Illustrated bulletin descriptive of various types of die heads and threading machines for munitions threading operations.

LOCOMOTIVE SPOTTER.—Whiting Corporation, Harvey, Ill. Eight-page Bulletin No. LS-C-400. Illustrates and describes construction and operation of high-capacity machine for spotting locomotives while squaring valves, connecting locomotives and tenders, applying rods, etc.

◆

LOCOMOTIVE GAGES.—The Ashton Valve Company, 161-179 First street, Cambridge (Boston), Mass. Thirty-page catalog 44 R.R. Describes and illustrates locomotive gages for motive power, gage fittings, and testing equipment.

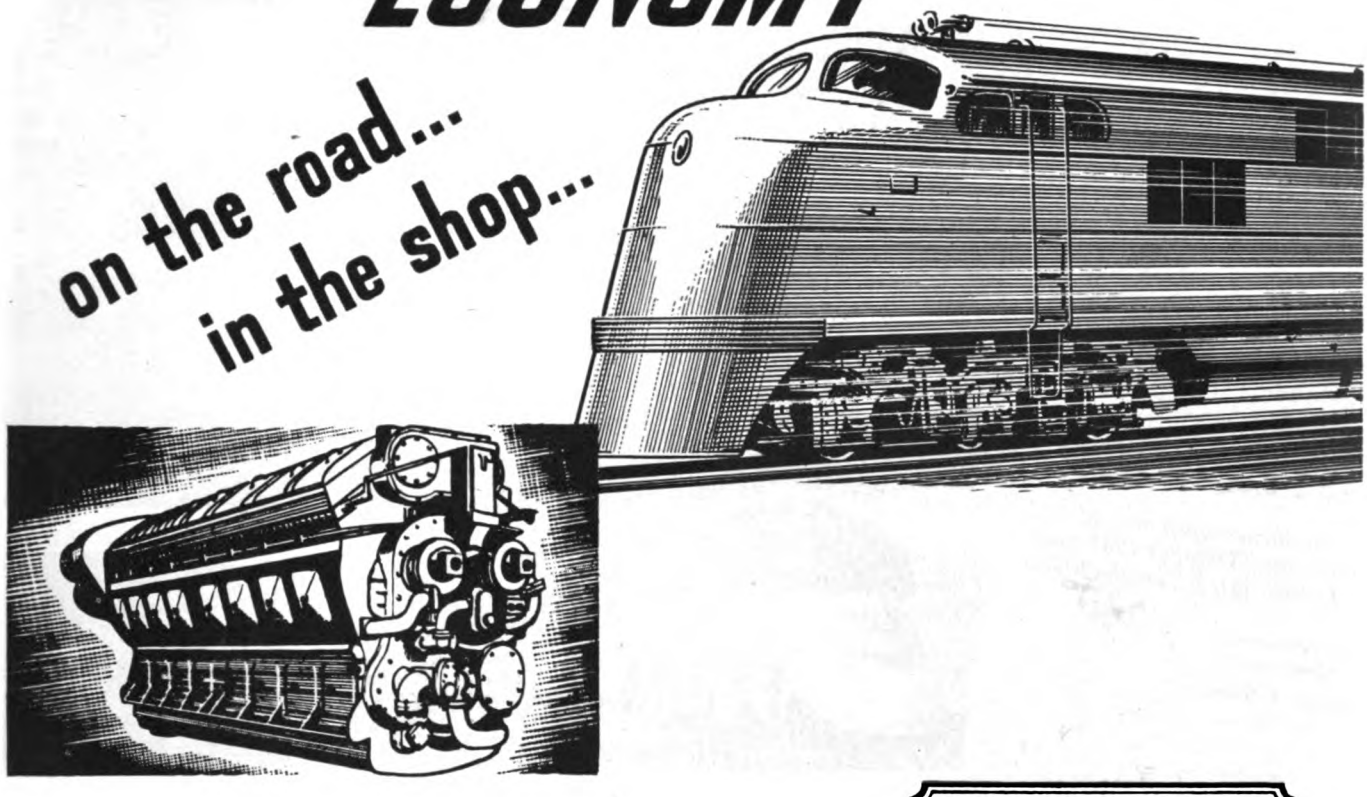
◆

V-BELT DRIVES.—The Dayton Rubber Manufacturing Company, Dayton, Ohio. Thirty-six-page illustrated catalog of pertinent data and facts concerning features and applications of Dayton "D-R" V-belt drives and accessories, with complete installation and maintenance instructions. Included also is a pocket-size edition of Parts List and Installation Instructions.


HOLLOW
flexible
STAYBOLTS
W. & L. E.

Leading roads profit by ECONOMY

on the road... in the shop...



FOR EXAMPLE: DE-SCALING DIESEL COOLING SYSTEMS THE SAFE OAKITE WAY

When you are confronted with the important job of de-scaling the cooling system of Diesel-electric locomotives in road or switching service . . . use the successful, SAFE Oakite method approved and standardized by many leading roads.

Let Us Give You More Data On This Maintenance Job

Circulating the recommended solution of Oakite Compound No. 32 quickly removes hard water scale deposits, restores heat transfer and desired cooling efficiency so that you get smooth engine performance. Since it costs nothing to find out . . . let us send you complete data describing this SAFE, economical Oakite method for cleaning and de-scaling Diesel cooling systems. Won't you write us today?

QUALITY MATERIALS
PROMPT DELIVERY
COMPETENT SERVICE

You can depend on all three when you specify Oakite cleaning on any or all your maintenance work:

Cleaning air conditioning equipment

—

Stripping paint from tanks, coaches, locomotives

—

Cleaning air compressors

—

Steam cleaning motion gear

—

Washing stainless steel and aluminum cars

OAKITE

RAILWAY SERVICE DIVISION

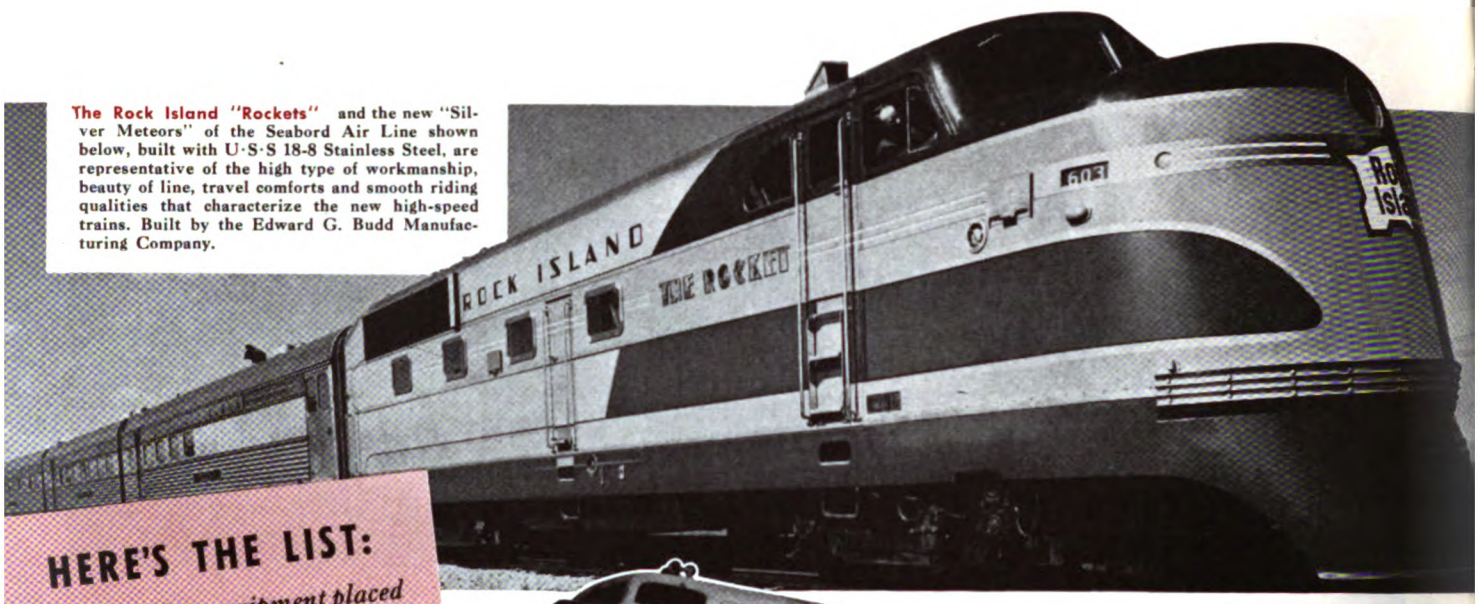
OAKITE PRODUCTS, INC. 46 Thames St. NEW YORK, N. Y.

REPRESENTATIVES IN ALL PRINCIPAL CITIES OF THE U. S. AND CANADA

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39 New Streamliners

The Rock Island "Rockets" and the new "Silver Meteors" of the Seabord Air Line shown below, built with U·S·S 18-8 Stainless Steel, are representative of the high type of workmanship, beauty of line, travel comforts and smooth riding qualities that characterize the new high-speed trains. Built by the Edward G. Budd Manufacturing Company.



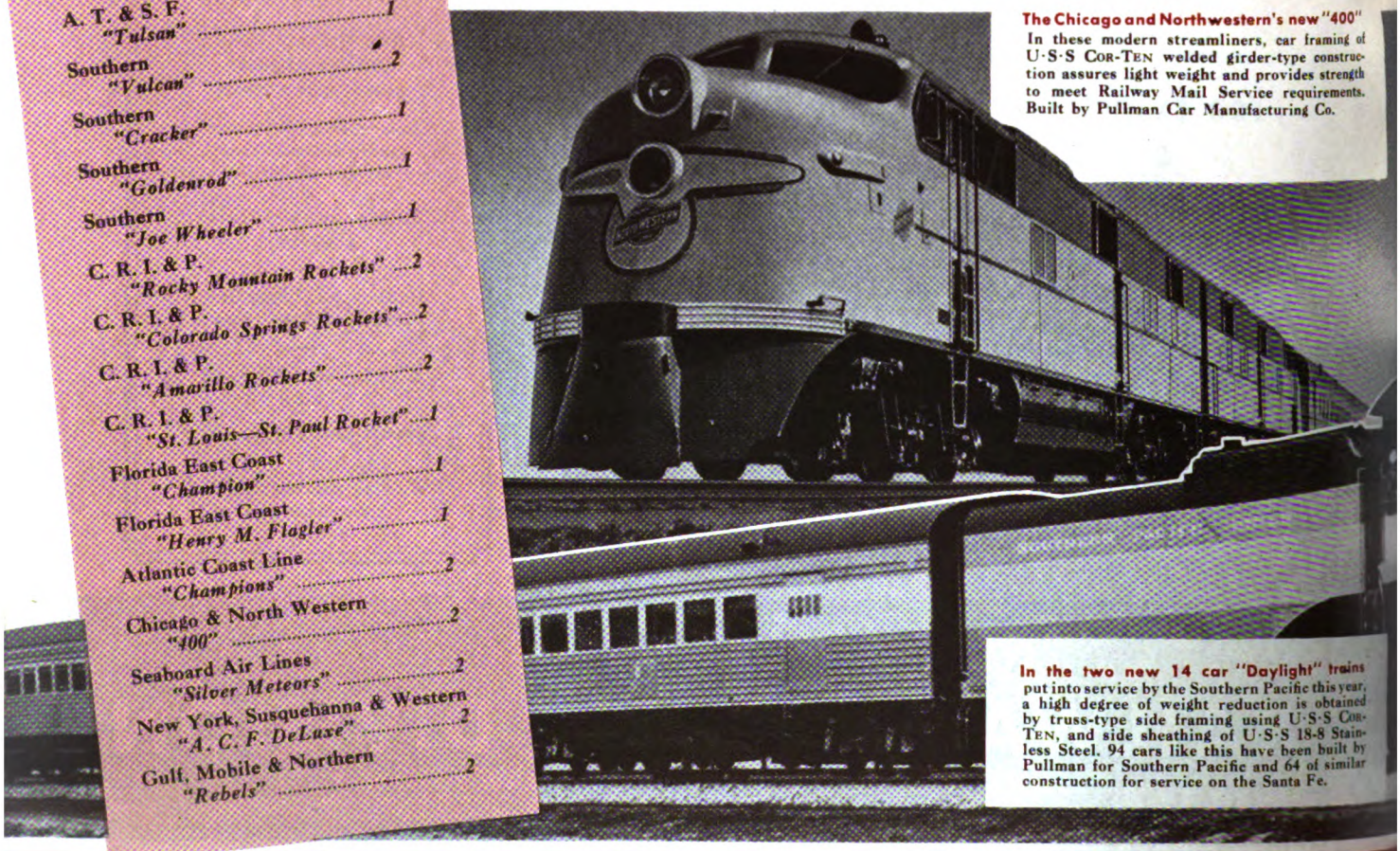
HERE'S THE LIST:

Traffic-building equipment placed in service since October 1939 built with U·S·S High Tensile Steels

Southern Pacific *"Daylights"*	2
Colorado & Southern *"Zephyrs"*	2
C. B. & Q. *"Silver Streak"*	1
A. T. & S. F. *"Tulsan"*	1
Southern *"Vulcan"*	2
Southern *"Cracker"*	1
Southern *"Goldenrod"*	1
Southern *"Joe Wheeler"*	1
C. R. I. & P. *"Rocky Mountain Rockets"*	2
C. R. I. & P. *"Colorado Springs Rockets"*	2
C. R. I. & P. *"Amarillo Rockets"*	2
C. R. I. & P. *"St. Louis—St. Paul Rocket"*	1
Florida East Coast *"Champion"*	1
Florida East Coast *"Henry M. Flagler"*	1
Atlantic Coast Line *"Champions"*	2
Chicago & North Western *"400"*	2
Seaboard Air Lines *"Silver Meteors"*	2
New York, Susquehanna & Western *"A. C. F. DeLuxe"*	2
Gulf, Mobile & Northern *"Rebels"*	2



The Chicago and Northwestern's new "400" In these modern streamliners, car framing of U·S·S Cor-Ten welded girder-type construction assures light weight and provides strength to meet Railway Mail Service requirements. Built by Pullman Car Manufacturing Co.



In the two new 14 car "Daylight" trains put into service by the Southern Pacific this year, a high degree of weight reduction is obtained by truss-type side framing using U·S·S Cor-Ten, and side sheathing of U·S·S 18-8 Stainless Steel. 94 cars like this have been built by Pullman for Southern Pacific and 64 of similar construction for service on the Santa Fe.

U·S·S HIGH TENSILE STEELS

since last October...

31 built with service-tested U·S·S High Tensile Steels!

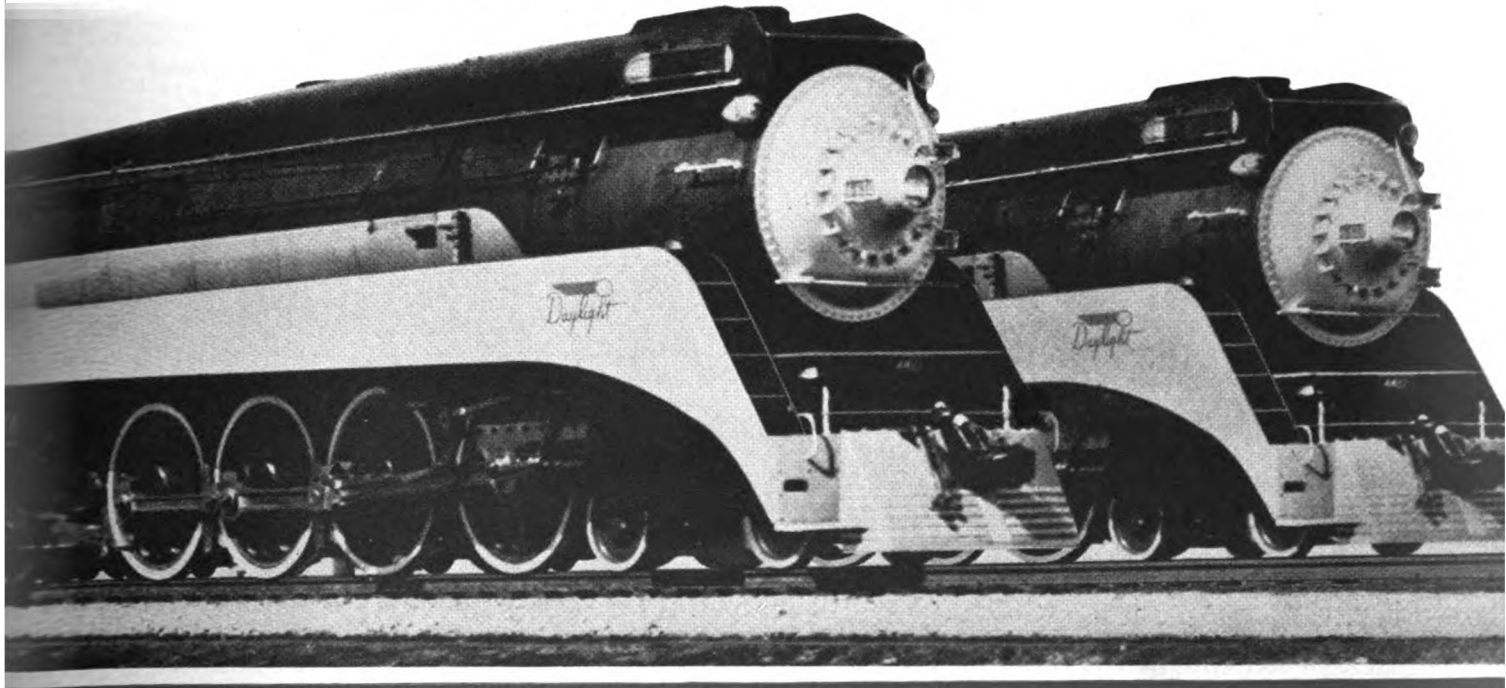
THE large number of modern streamlined trains placed in service in the past 12 months establishes a record in railway history.

We believe it especially noteworthy that again in 1940, as in 1939, almost 80% of this new equipment was built with U·S·S High Tensile Steels —U·S·S Cor-Ten and U·S·S 18-8 Stainless.

This is more than a happy accident. These steels have honestly earned their place as preferred materials for lightweight passenger car construction. Extensive experience in application and in service has proved them eminently fitted for such use. From the standpoint of design, their high strength-weight ratio makes them inherently adapted for lightweight construction. Their greater fatigue strength, which assures greater resistance to vibration, and the high modulus of elasticity of steel, which permits light construction without excessive deflection, are prime factors in determining their choice for such an overwhelming proportion of the modern passenger equipment produced to date.

Important, too, is the fact that both U·S·S Cor-Ten and U·S·S 18-8 Stainless are readily formed and fabricated by all the commonly used shop processes—that both are suitable for spot welding, which makes for efficient and economical joining of light members.

AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
NATIONAL TUBE COMPANY, *Pittsburgh*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Export Company, New York
Scully Steel Products Company, Chicago, *Warehouse Distributors*



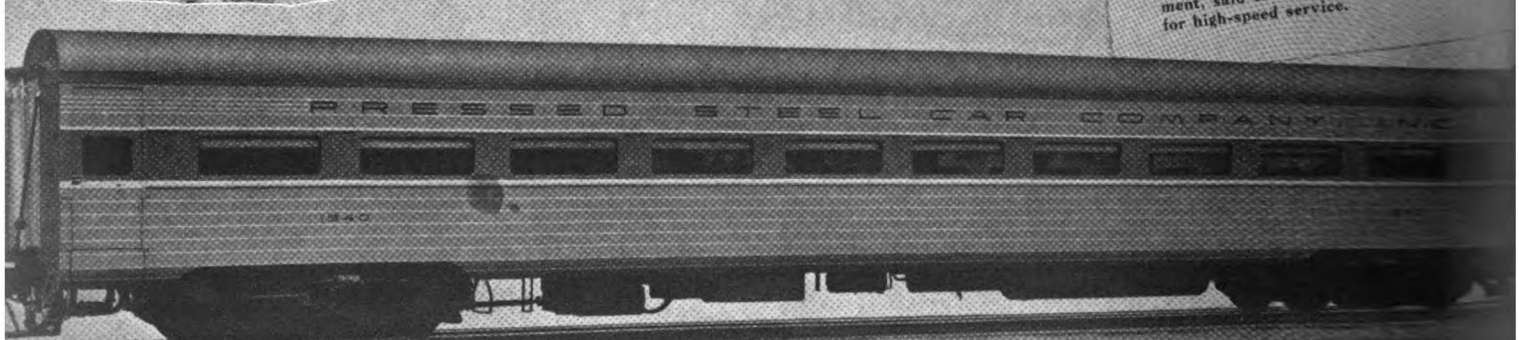
UNITED STATES STEEL

1300 revenue-boosting









In six 2-car streamlined units of the Southern Railway shown above, U·S·S COR-TEN is used throughout in building the under-frames and also in the super structure where strength and lightness at low cost were essential. Car weight per passenger has been reduced to 1454 lb. These six 2-car units have released a total of 6 steam locomotives, 6 mail compartment cars and 10 coaches for other service. Built by St. Louis Car Co.

U·S·S Cor-Ten is used extensively in the structural members of the two 80-passenger motor rail cars of the New York, Susquehanna and Western, placed in service July, 1940. They make the 15.3-mile trip between Paterson City and Susquehanna Transfer in 20 minutes. This new service in conjunction with bus connection saves commuters about one hour per day between Paterson City, N. J., and Times Square, New York. Built by American Car and Foundry Co.

Five of these DeLuxe Pennsylvania dining cars built principally of U·S·S COR-TEN, weigh 113,240 lb. each, light, as compared with about 170,000 lbs. for former conventional design. In a compression test these COR-TEN cars exceed specified requirements. Built by A.C.F.

Modern streamlined coach (below) built by Pressed Steel Car Co. is 84 ft. 8 in. long over face-plates and weighs only 111,200 lb. in running order but exceeds all A. A. R. strength requirements. Body structure substantially all of U·S·S COR-TEN. Notice the unique window arrangement, said to be especially advantageous for high-speed service.

U·S·S HIGH TENSILE STEELS

passenger cars tell the story

...prove the superiority of U·S·S High Tensile Steels for reducing weight without sacrifice of strength or stamina

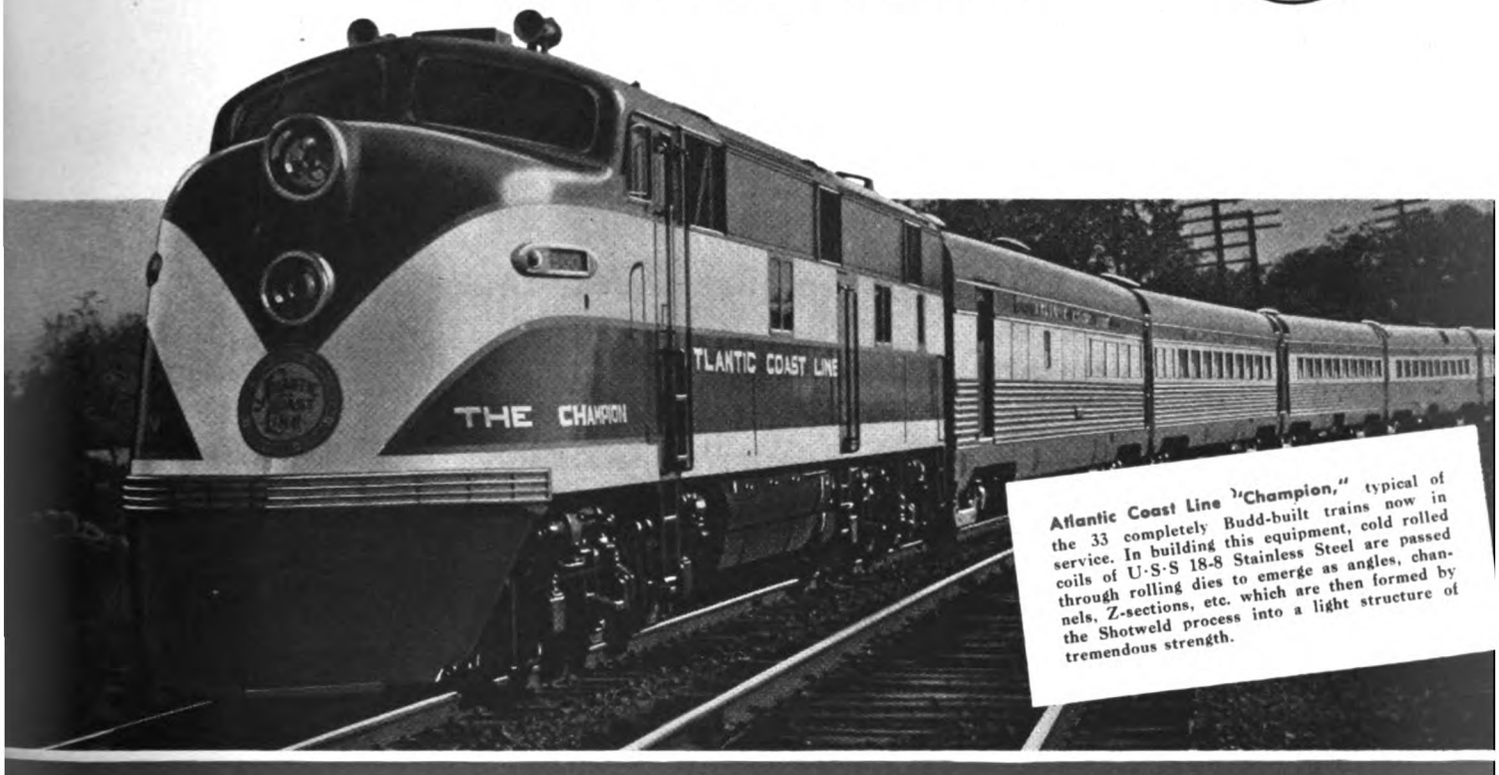
IMPROVED lightweight design, better fabricating methods and judicious application of these superior steels—U·S·S Cor-Ten and U·S·S 18-8 Stainless—have made it possible for designers and car builders to reduce passenger car weights generally 30% to 40%. And these weight savings have been accomplished without the loss of a single advantage previously enjoyed.

With this lighter equipment the railways have been able to provide superior service to the public at lower cost to themselves. By reducing the 650 tons represented by the conventional 8-car train to 400 tons, they have obtained equivalent train performance with 1/3 less locomotive capacity. The result has been important and substantial savings. First, from the lowering of initial cost of motive power and second, from the decrease in fixed charges and fuel costs throughout the life of the equipment.

The economic advantages of passenger equipment built of U·S·S High Tensile Steels are exemplified by many of the premier trains that are making new records in traffic and net earnings. Take, for example, the case of the "Daylight" trains of the Southern Pacific. In these 14-car streamliners, a weight reduction of 29.7% is obtained by truss-type side framing using U·S·S Cor-Ten and side sheathing of U·S·S 18-8 Stainless. Earnings have been outstanding—have run as high as $6.28 per train mile and the popularity of the service has made necessary the addition of the two new ultra modern trains added to the "Daylight" fleet this year.

This is not an isolated case, but a typical example as proved by repeat orders to extend the service of the "Zephyrs," "Rebels," "Hiawatha," "Rockets" and other famous trains—all built with U·S·S High Tensile Steels. It is on this record of proved accomplishment that we offer these superior steels for your consideration.

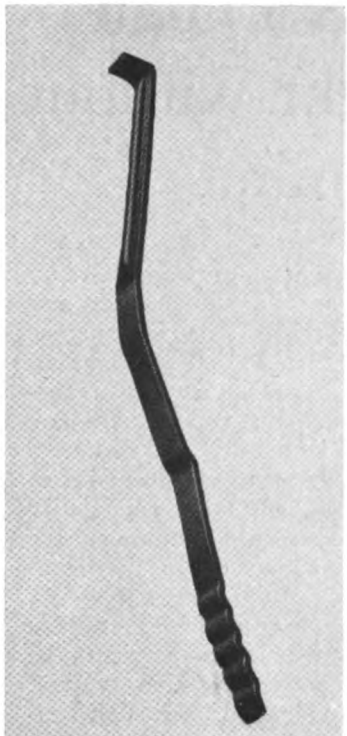
AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
NATIONAL TUBE COMPANY, *Pittsburgh*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Export Company, New York
Scully Steel Products Company, Chicago, *Warehouse Distributors*



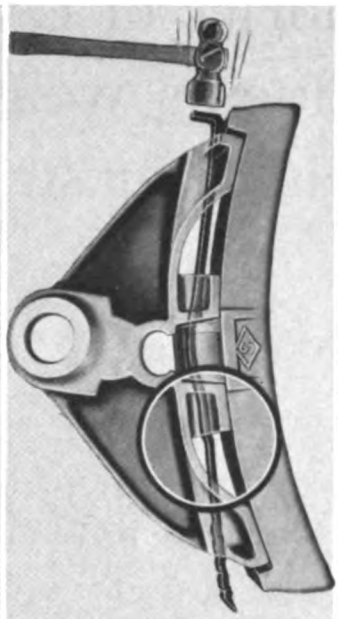
Atlantic Coast Line "Champion," typical of the 33 completely Budd-built trains now in service. In building this equipment, cold rolled coils of U·S·S 18-8 Stainless Steel are passed through rolling dies to emerge as angles, channels, Z-sections, etc. which are then formed by the Shotweld process into a light structure of tremendous strength.

UNITED STATES STEEL

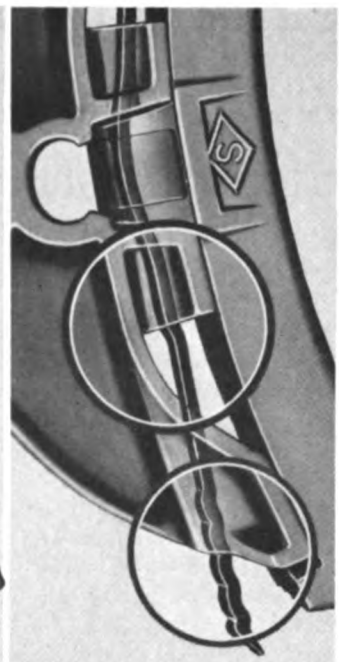
Approved as Alternate



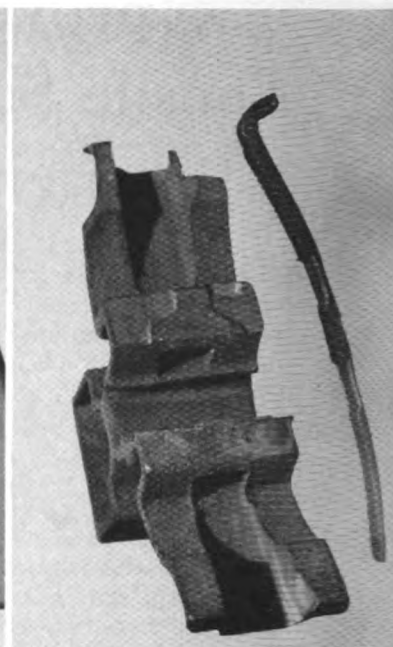
Made of alloy spring steel especially heat treated, the Brake Shoe Lockey serves a triple purpose.



When driven to correct position, the offset in the key drops over the lower pad of the brake head ...



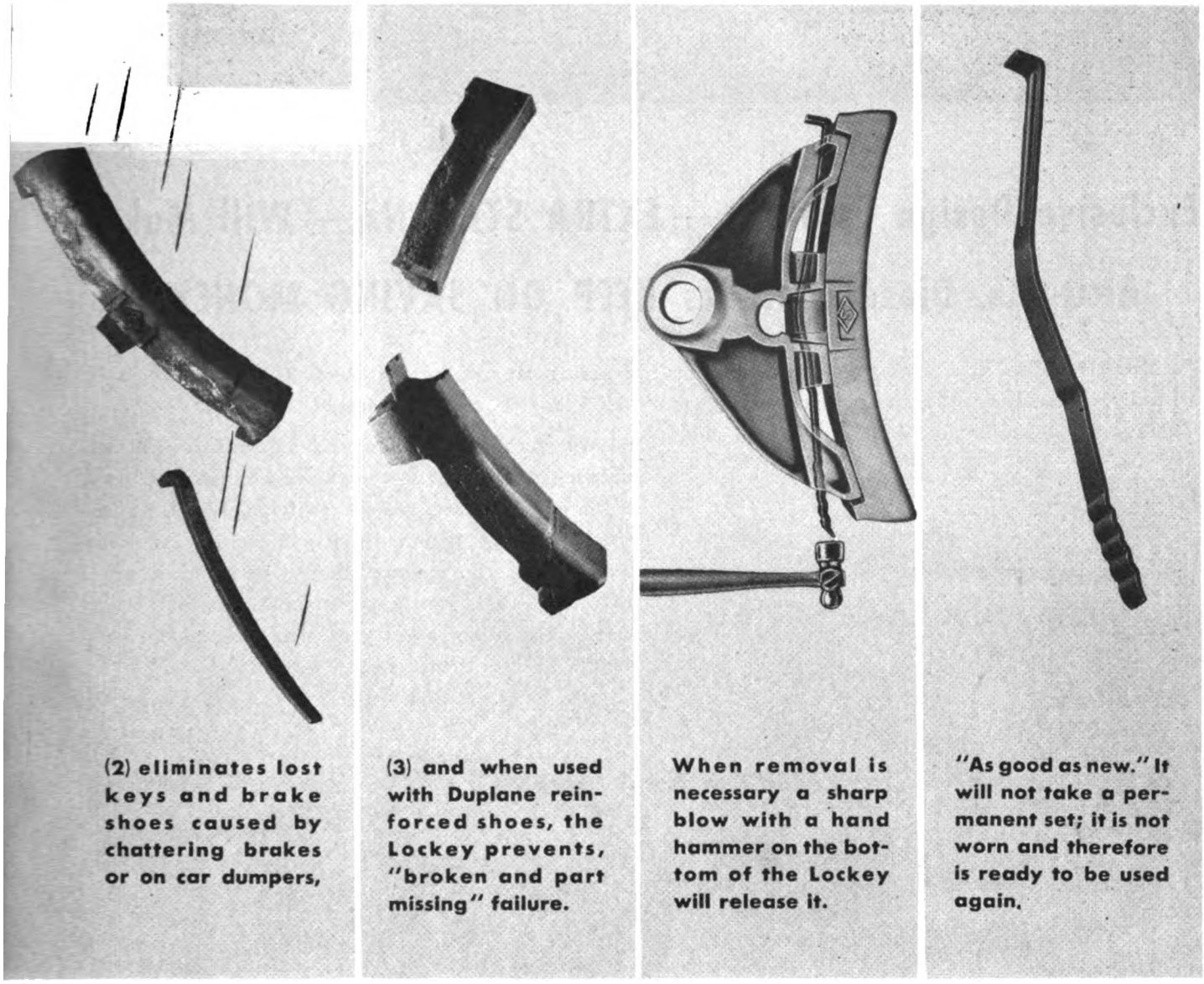
Where it locks in position, holding brake shoe and head so tightly together that ...



(1) it eliminates wear of brake head and key and

The A.A.R. in adopting the Brake Shoe Lockey as Alternate Standard has signified its approval of the device which our engineers have developed to solve the problem of providing a simple, rugged and durable means of attaching brake shoe to brake head so firmly that loss of shoes or keys is prac-

Standard by the A.A.R.



(2) eliminates lost keys and brake shoes caused by chattering brakes or on car dumpers,

(3) and when used with Duplane reinforced shoes, the Lockey prevents, "broken and part missing" failure.

When removal is necessary a sharp blow with a hand hammer on the bottom of the Lockey will release it.

"As good as new." It will not take a permanent set; it is not worn and therefore is ready to be used again.

tically eliminated and wear of heads reduced to a minimum.

Of additional importance to users is the fact that the Lockey can be used repeatedly without sacrificing any of its efficiency as a locking medium.

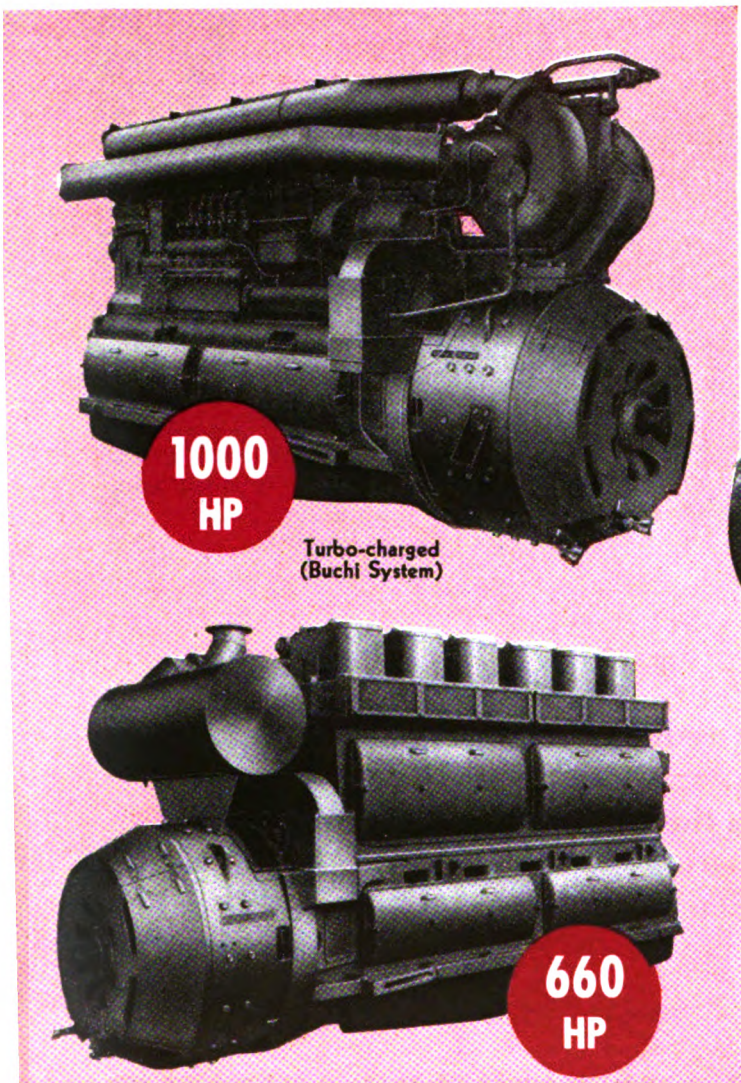
THE AMERICAN BRAKE SHOE AND FOUNDRY COMPANY
BRAKE SHOE AND CASTINGS DIVISION

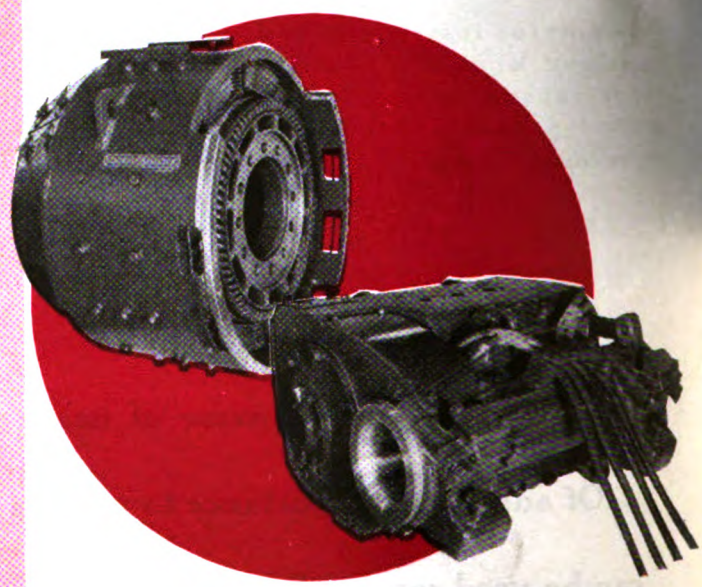
Long after they give

Exclusive Design Features—EXTRA STAMINA—Will Make Alco-G.E. Diesel-electrics KEEP ON SAVING MONEY

FLASH-IN-THE-PAN economy records don't mean much. Inherently lower operating costs and higher availability will always enable diesel-electrics to show a saving over steam switchers. The big question is, "How long will the saving last?"

Besides all the regular money-saving features of diesel-electrics, Alco-G.E. switchers have a number of extra advantages for fast, smooth switching—such as improved visibility, patented split-pole exciter, and 3-way operation of the traction motors. But, even more important, their sturdy, dependable construction assures low-cost operation year after year—long after they've paid for themselves.



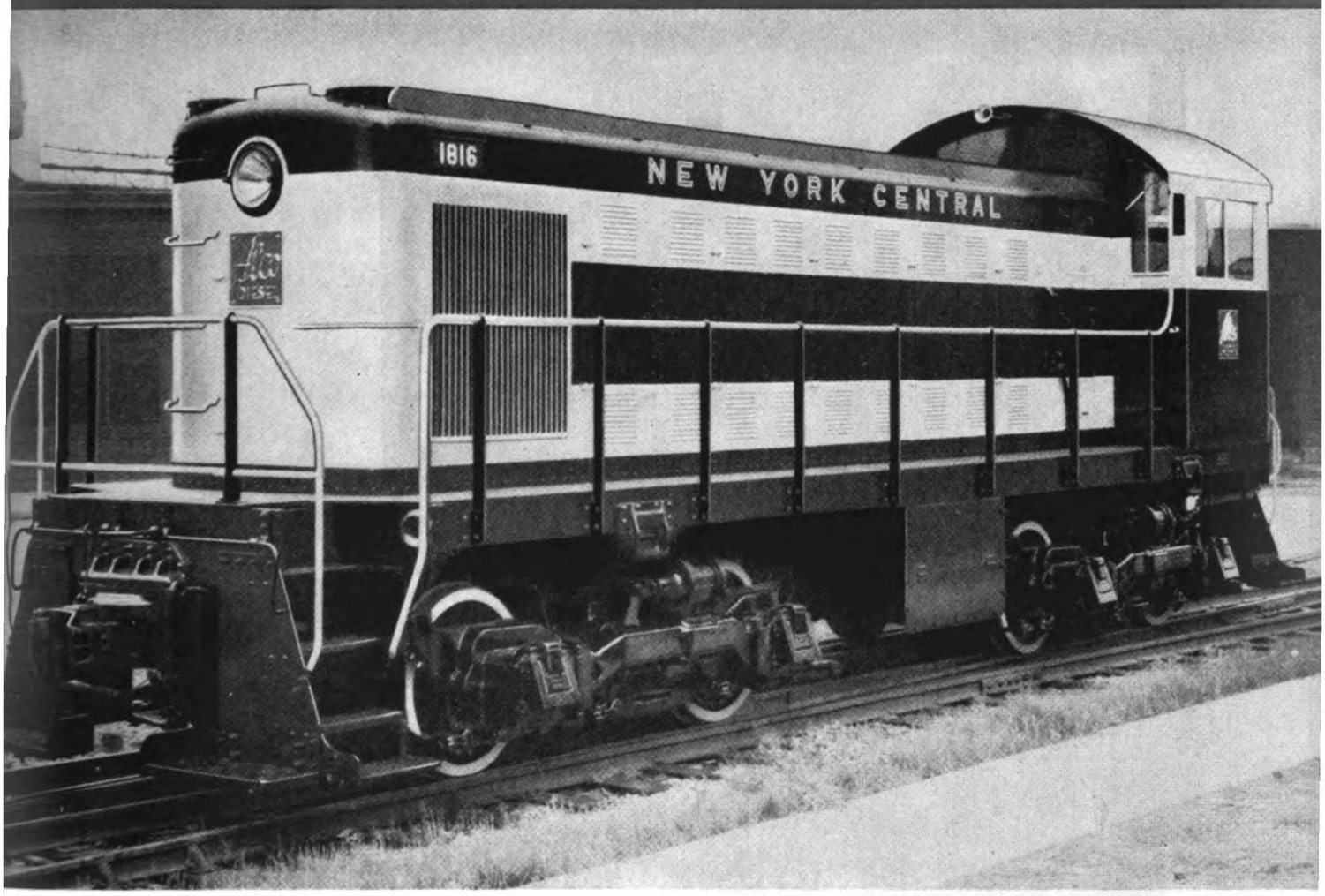


Alco DIESEL

GE

SWITCHING POWER THAT HAS EARNING POWER!

paid for themselves



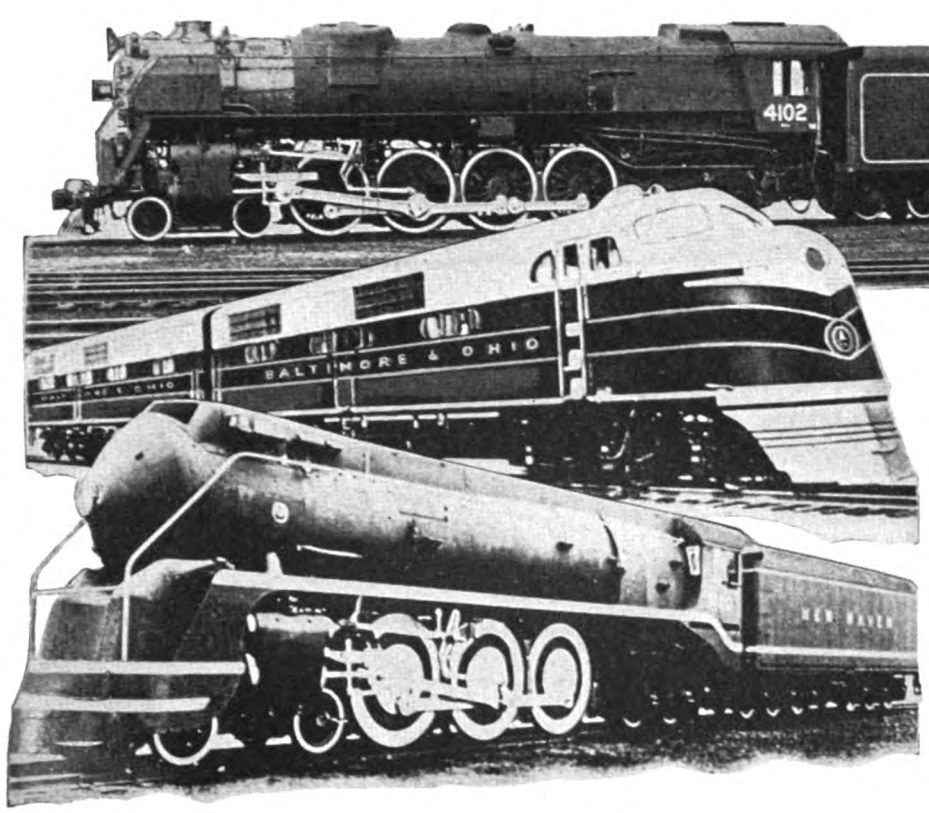
Consider the engine, for example. Every part of Alco's 4-cycle diesel is strong, thoroughly reliable, and easy to understand and maintain. Liners are perfectly symmetrical cylinders with no ports. Piston-pin trouble is unknown because, in 4-cycle engines, reversal of load allows lubrication on both sides of the pin. Pressures and temperatures are inherently low. These factors, combined with Alco's policy of conservative rating, mean low fuel cost, low lubricating-oil consumption, amazingly little maintenance, and *long life.*

G-E electric drive has many important improvements to prolong engine life by producing more rapid acceleration and higher average and top speeds for given engine speeds. New traction motors with exceptionally rigid armatures reduce wear on gears and pinions and lengthen their life.

Alco-G.E. switchers are built for heavy-duty railroad work by the two pioneer builders of railroad motive power. They represent more than 100 years of experience designing locomotives and 50 years building electric drive. No wonder they have an extra measure of stamina to make them an exceptionally profitable investment.

AMERICAN LOCOMOTIVE COMPANY, NEW YORK, N. Y.
GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

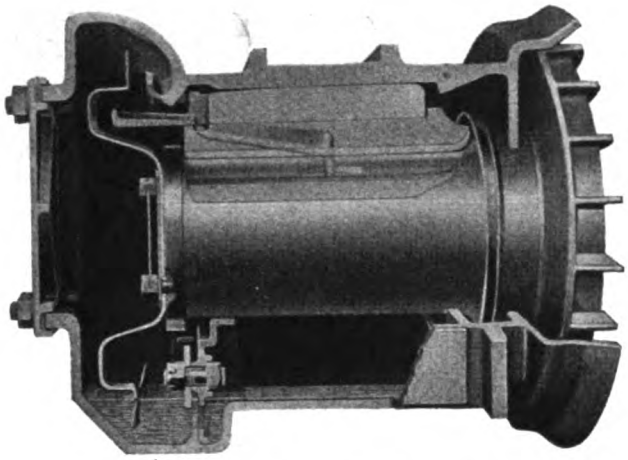
AMERICAN LOCOMOTIVE AND GENERAL ELECTRIC



MILLIONS OF MILES

with a

Proven Product



NATIONAL ISOTHERMOS JOURNAL BOXES

Lowest Friction of any Journal Box made,
because a positive oil film carries the load.
Long Axle Life - - - Long Journal Bearing Life.
No Waste Grabs.
Low initial Box and Axle cost.

NATIONAL MALLEABLE AND STEEL CASTINGS CO.
General Offices: CLEVELAND, OHIO
Sales Offices: New York, Philadelphia, Chicago, St. Louis, San Francisco
Works: Cleveland, Chicago, Indianapolis, Sharon, Pa., Melrose Park, Ill.

Steel- FIRST LINE OF NATIONAL DEFENSE



Republic Operates the World's Largest Stainless Steel Finishing Mill—

Ten years ago, Republic operated the world's largest stainless steel finishing plant. Each year it seemed to become smaller as ENDURO Stainless Steel found its way into new products—automobiles, trains, airplanes; chemical, textile and food processing equipment; home appliances and even fine jewelry.

Actually, the plant has been enlarged—now covers five acres of floor space—and much new finishing equipment has been added so that, today, Republic still operates the largest stainless steel finishing plant in the world.

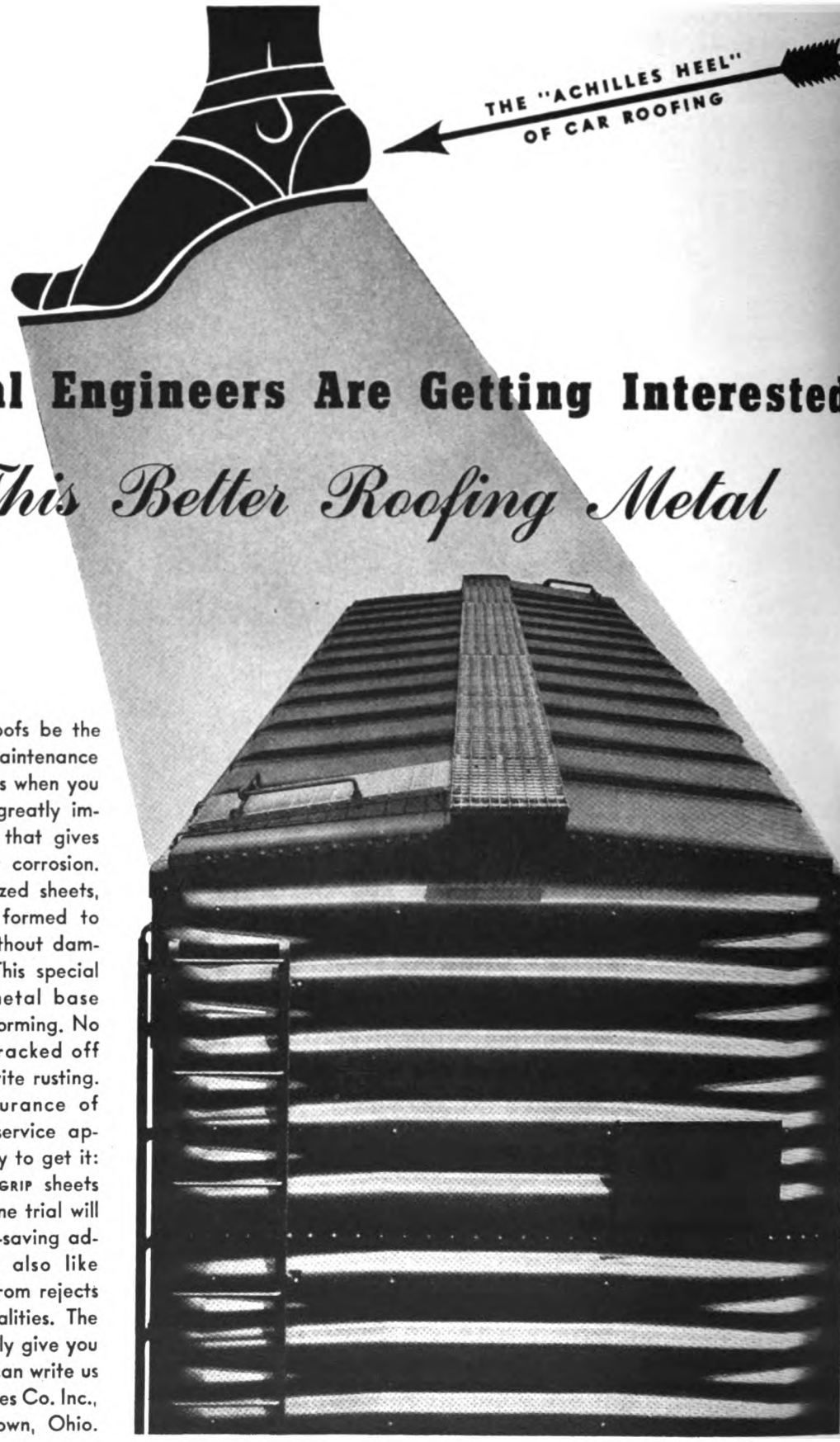
Now, to the huge peace-time need for ENDURO for a wide variety of every-day uses is added the demand of industry working feverishly in the defense of America—for bomb chutes in planes, galleys in naval craft, floats for flying boats and a host of other uses where high strength and heat- and corrosion-resistance are imperative.

Republic has looked ahead – has expanded all its facilities – and, fortunately for every man and woman interested in preserving our freedom, is able and anxious to help in the crisis that now squarely faces America – with more and better ***steel – first line of national defense.***

The line of steels and steel products manufactured by Republic is so diversified that we have prepared a complete listing in Booklet No. 199. A copy will be sent you upon request.

REPUBLIC STEEL CORPORATION • CLEVELAND, OHIO

BERGER MANUFACTURING DIVISION • CULVERT DIVISION • NILES STEEL PRODUCTS DIVISION
STEEL AND TUBES DIVISION • UNION DRAWN STEEL DIVISION • TRUSCON STEEL COMPANY



Mechanical Engineers Are Getting Interested

In This Better Roofing Metal

No longer need car roofs be the **"Achilles heel" in your** maintenance **budget. You'll discover** this when you **try ARMCO ZINCGRIP**—a greatly improved galvanized metal that gives **better protection against** corrosion.

Unlike ordinary galvanized sheets, **ARMCO ZINCGRIP can** be formed to **tight, intricate designs** without damaging **the zinc coating.** This special **coating sticks to** the metal base **through the most severe** forming. No **flaking or peeling.** No cracked off **seams or bare spots** to invite rusting.

Should this extra assurance of **water-tight, trouble-free** service appeal **to you, this is the** way to get it: **Just specify ARMCO ZINCGRIP** sheets **on your next car order.** One trial will **convince you of its** money-saving advantages. **Car builders** also like **ZINCGRIP for its freedom** from rejects **and its good working** qualities. The **local ARMCO man will** gladly give you **more information, or** you can write us **direct. Armco Railroad** Sales Co. Inc., **2901 Curtis St., Middletown,** Ohio.

ARMCO ARMCO **ZINCGRIP SHEETS**

GIVE FULL PROTECTION

BALDWIN *Diesel-Electrics*



De La Vergne 660-hp. 4-Cycle Diesel engine. Westinghouse generator.

Simplified ENGINE MAINTENANCE

The De La Vergne 1000-hp. and 660-hp. engines, built by Baldwin for their Diesel-electric switching locomotives, are designed to give direct and safe access for inspection and maintenance.

FIVE IMPORTANT POINTS:

1. *Overspeed governor* readily accessible for checking.
2. Periodic testing of *hydraulic governor* and associated operating parts made easy.
3. *Injection nozzles* can be quickly removed for inspection.
4. Continuous supervision of combustion conditions by means of the *pyrometer.*
5. Shoulder high position of *injection pumps* makes for quick inspections.

BLW THE BALDWIN GROUP

THE BALDWIN LOCOMOTIVE WORKS

Philadelphia



NICKEL ALLOY STEELS

New Nickel-bearing stainless steel "Silver Meteors" proved veritable gold mines for the Seaboard Railway this season. These sleek luxury-coach streamliners attracted waiting lists of passengers for the New York—Miami—St. Petersburg runs. Frills aplenty—eye-appeal that wins revenue—and plenty of appeal for practical railroaders in 1940 designs which minimize deadweight, reduce wear, resist corrosion and cut down upkeep. Every mile, every month, Nickel steels save you dollars.

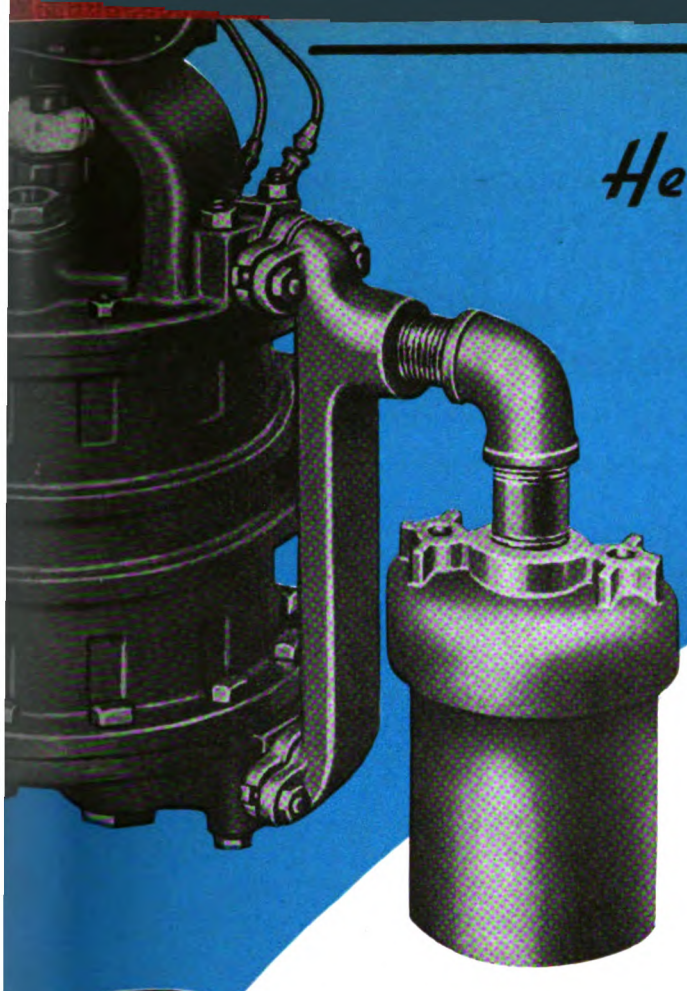
Meteor coaches, products of Edward G. Budd Mfg. Co., are constructed almost entirely of stainless chromium-Nickel steel, including end underframes, body bolsters and center sills. The latter part is designed to take a buffing load of 900,000 lbs. within the limits of working stresses. Nickel-containing stainless steel is also used for car interior trim as well as drinking water tanks.



The Meteor locomotives, products of the Electro-Motive Corp. (subsidiary of General Motors), La Grange, Ill., are each powered by two 1000 HP Diesels in which Nickel alloys are specified for various stressed parts. Connecting rod forks are made of SAE 3140 Nickel-chromium steel. Driving gears, engine bolts and studs and miscellaneous stressed shafts are of SAE 3135 Nickel-chromium steel. A high strength Nickel alloy cast iron is used for blower timer gears and for cylinder heads and liners. In the locomotives themselves roofs are made of a high tensile low alloy Nickel steel and all truck frames are cast in 2¼% Nickel steel.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK, N. Y.

Here's where it's WISE to "*Strain at a Gnat*"





. . . The Compressor AIR INLET

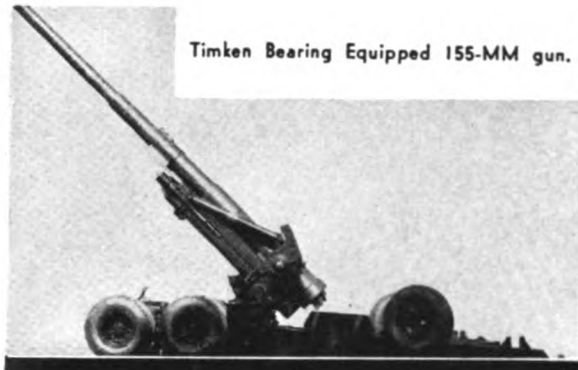
ANY dirt that enters the compressor suction is harmful. It reduces performance integrity and shortens service life. Even fine dust will in time cause excessive wear, stuck rings, and clogged air passages. Therefore to exclude *all* dirt is vital ★ The only way of accomplishing this is to *filter* the intake air, not merely strain it. Our G-1 Suction Filter will do this effectively. It precipitates heavy particles of dirt and intercepts even fine dust suspended in the air. To thus keep compressors clean brings worthwhile operating and maintenance advantages ★ Many railroads have proved that when this filter is used instead of a small inferior strainer their compressors can be kept on the locomotive three to six times as long without overhauling. **In the meantime, performance remains consistently reliable ★ Think of the economies YOU too can thus effect — elimination of costly delays due to faulty compressor operation or failure — extension of time between cleaning and renewal — reduction in number of replacements (more pronounced when standard Westinghouse repair parts are used exclusively).**

The G-1 SUCTION FILTER comprises a removable element made of high grade close-textured felt of large area, radially pleated over reinforcing wire mesh, and encased in a detachable dirt chamber. It is compact; easy to handle, clean, and replace. Simple, economical maintenance is thus possible.

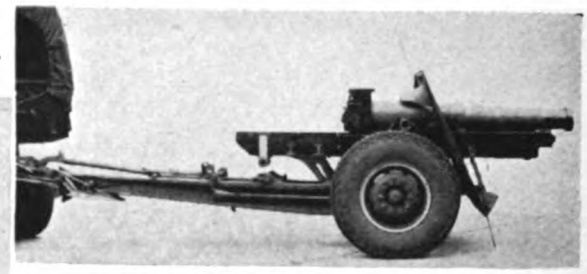
This Suction Filter will save many times its cost in reduced maintenance expense because it helps to eliminate faulty compressor operation and shortening of service life that results from destructive dirt. To "strain at a gnat" now will prevent necessity for "swallowing a camel" later!

WESTINGHOUSE AIR BRAKE COMPANY

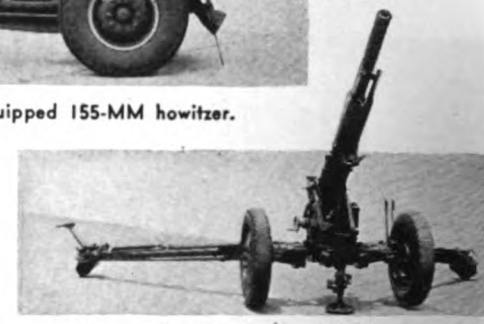
WILMERDING PENNSYLVANIA



Timken Bearing Equipped 155-MM gun.



Timken Bearing Equipped 155-MM howitzer.

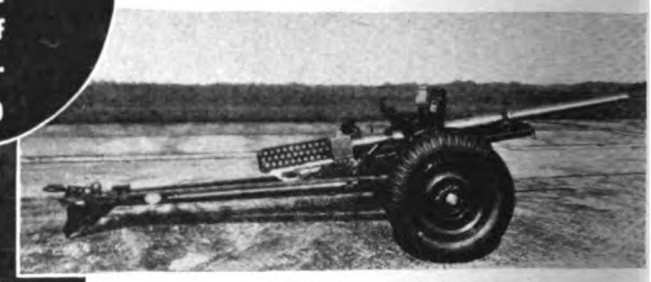


Timken Bearing Equipped 75-MM field gun.

For Defense

Wherever wheels and shafts turn, the extra strength, endurance and accuracy of TIMKEN Bearings are facilitating the mechanization of our military forces . . . both in the equipment itself and in the precision machinery necessary to produce it.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO



Timken Bearing Equipped 37-MM gun.

Timken Bearing Equipped light tank. →

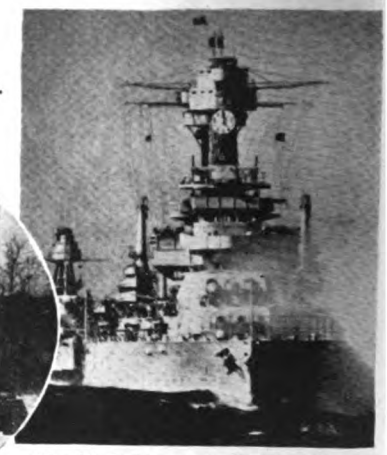
Timken Bearing Equipped 4-ton truck. ↓





Timken Bearing Equipped 1½-ton truck. ↓

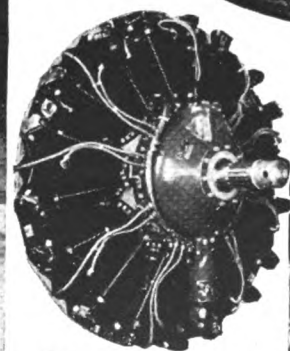




The U. S. Navy uses Timken Bearings in many kinds of equipment afloat and ashore.

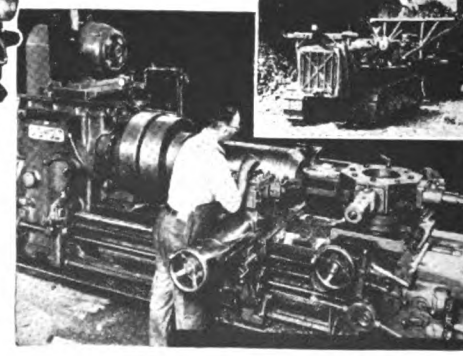
U. S. military airplanes take off and land on Timken Bearing Equipped wheels.





Power for U. S. war birds—Timken Bearing Equipped engines.

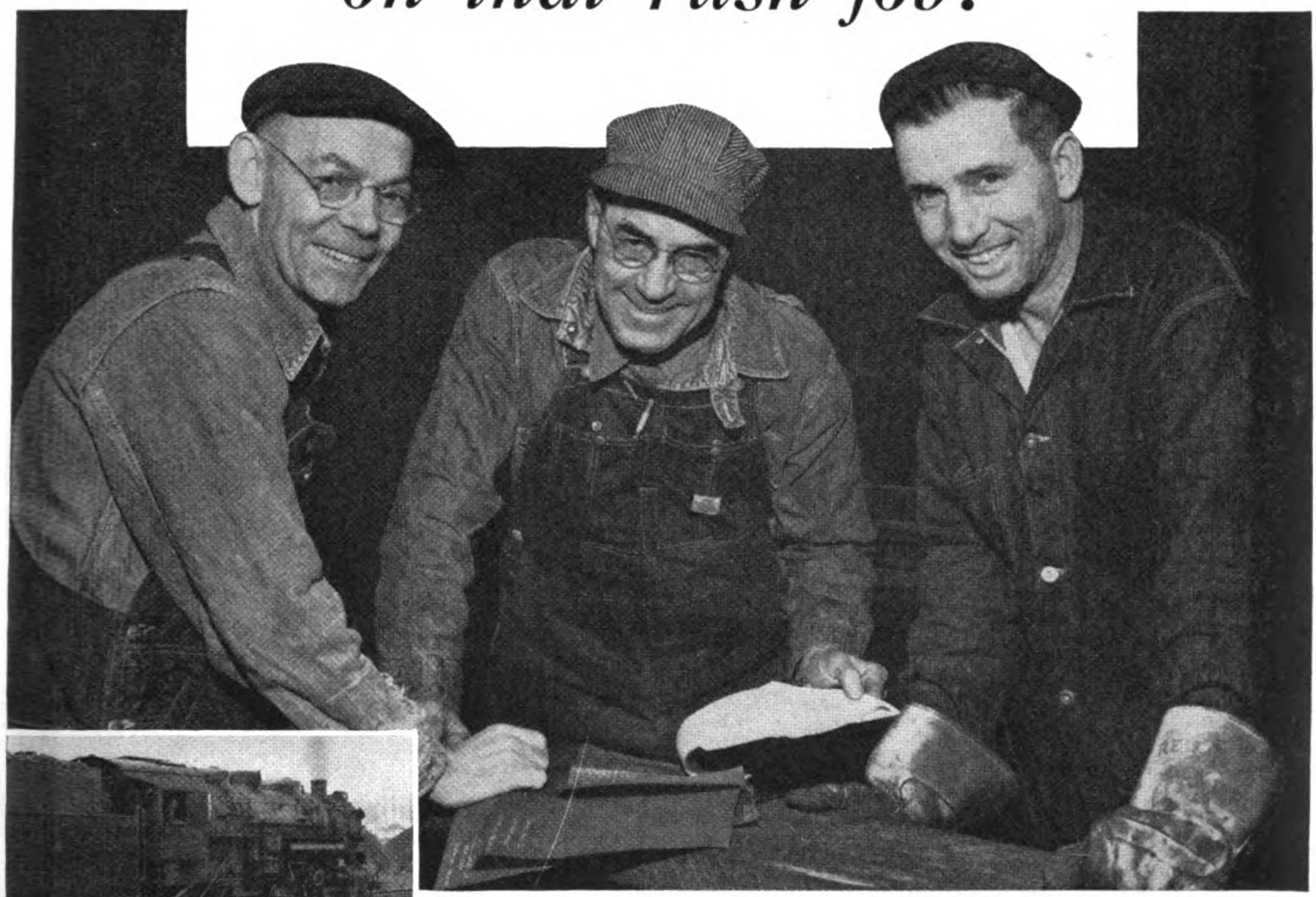




U. S. Army Engineers use a wide variety of Timken Bearing Equipped machines.

Millions of dollars worth of Timken Bearing Equipped precision machine tools will speed up our vast defense program.

We sure saved time on that rush job!





"THE foreman frowned when No. 89 limped into the shop yesterday morning with a rush tag on her. They wanted her back for the Thursday schedule. We heard him say there wasn't a ghost of a chance.

"But there she goes—finished several hours ahead of schedule."

Unless you work with boiler tubes, it's hard to believe that they could make so much difference. A tube that flares, rolls, and beads easily saves minutes all along the line. It never splits or cracks. It eliminates waste in time and materials. And when you add up all those minutes saved, you'll find that a change to NATIONAL Seamless Boiler Tubes will often save several hours on a single repair job.

Controlled annealing gives these tubes exactly the right properties—makes them just soft enough for easy installation, just hard enough for maximum strength. Each tube is pierced from a solid billet of highest quality killed open-hearth steel, then rolled inside and out to produce walls of uniform strength throughout. These tubes have no weld, no line of longitudinal weakness. They are "Walls Without Welds," strong, uniform, and easy to install. Specify them both for new equipment and old, as extra assurance of long, satisfactory service. Our Field Service men will be glad to help with your problems.

NATIONAL TUBE COMPANY

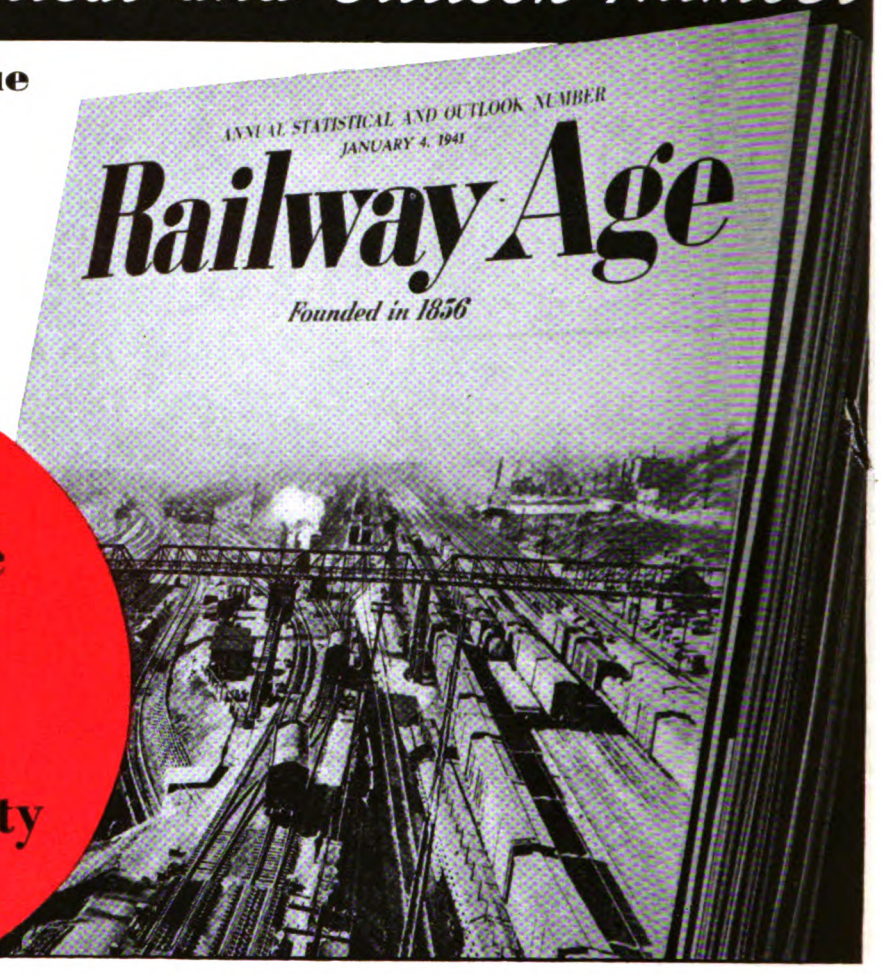
PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

Annual Statistical and Outlook Number

January 4, 1941, Issue



The Authoritative Record of the Year's Railway Activity

EACH year, the Annual Statistical and Outlook Number of the *Railway Age* provides a comprehensive and authoritative record of the past twelve months' railway activities and the outlook for the year ahead . . . statistical and analytical information, much of which is available from no other source.

The 1941 Annual Number will be the January 4, 1941, issue of the *Railway Age*. It will be unusually timely because of the vital importance of railway transportation facilities in the national defense program.

An institution of more than thirty years' standing, this important reference volume furnishes a vital statistical record which is sought and used in all quarters. In fact, each year, hundreds of extra copies are purchased by the railways so that ample copies will be available for continuous reference throughout the year.

Again in 1941, the Annual Number will contain both a comprehensive outlook section and a statistical and review section. The outlook section will feature a series of articles discussing the important trends and developments in the railway industry today. The statistical and review section will analyze railway operations of 1940, and will present detailed statistical information on all phases of 1940 activities, including the annual compilation of orders for equipment.

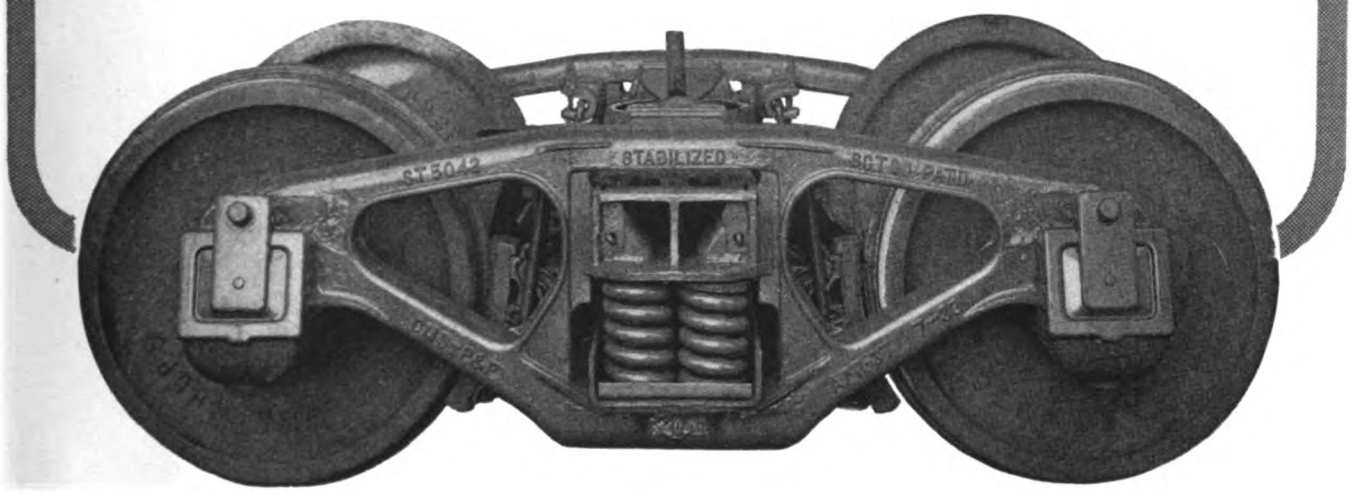
To Manufacturers

The Annual Statistical and Outlook Number offers manufacturers an unusually timely opportunity to start their 1941 sales campaign vigorously in all parts of the railway industry. With the uptrend in railway activity, the stage is set for a detailed presentation of your railway products to key railway men in all parts of the railway industry who will read and refer to the Annual Statistical and Outlook Number. Write your nearest *Railway Age* office for more information and for making space reservations.

Simmons-Boardman Publishing Corp.
30 Church Street, New York, N. Y.
105 West Adams Street, Chicago — Terminal Tower, Cleveland
Washington, D. C. — Los Angeles — San Francisco — Seattle

Railway Age . . . January 4, 1941

MORE *Miles* PER CAR



HAVE YOUR TRUCKS BARBER STABILIZED

Maximum utilization of freight equipment through greater mileage per car and heavier loading, are recognized by railroads and shippers alike as major factors in the solution of unprecedented transportation problems that lie just ahead.

Easy riding cars that reduce maintenance and minimize the time spent in repair shops, unquestionably contribute to the goal: "MORE MILES PER CAR."

When freight cars are BARBER STABILIZED, easy riding is **assured**—destructive spring bouncing and breakage are eliminated by controlled bolster spring action—cars and lading protected.

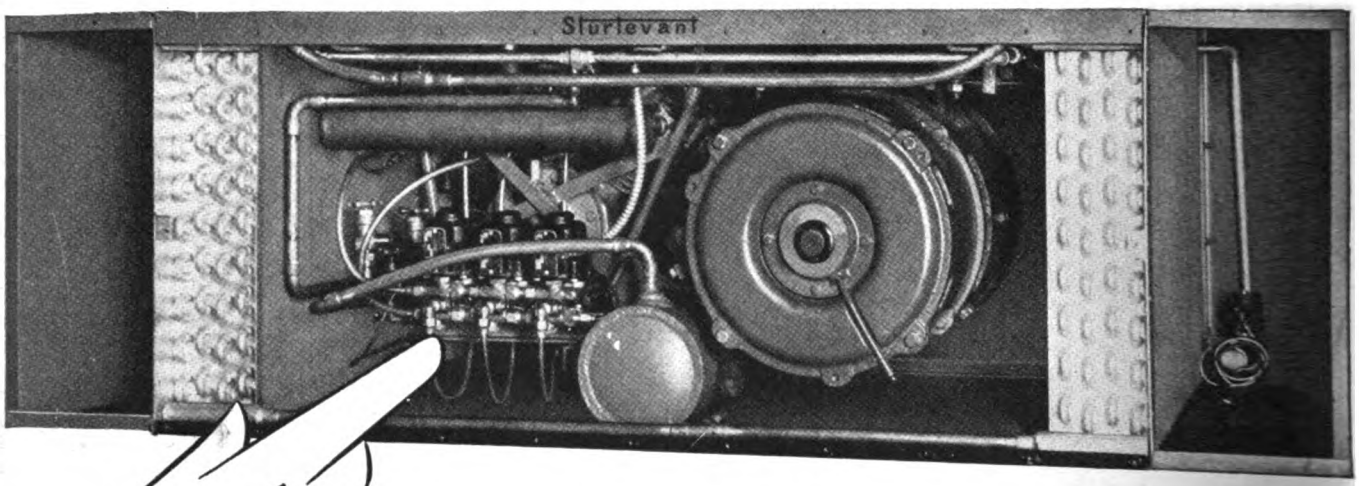
A truck that is BARBER STABILIZED is the **only** truck that is **initially tight** and always STAYS TIGHT. There's no looseness and wear between bolsters and columns. It automatically takes up its own wear.

Specify BARBER STABILIZED PARTS for long, satisfactory car life—trouble free service—reduced maintenance expense.

DESIGNED FOR USE WITH OR WITHOUT SPRING PLANKS — ALSO WITH OR WITHOUT LATERAL MOTION

STANDARD CAR TRUCK COMPANY
332 SOUTH MICHIGAN AVENUE CHICAGO, ILLINOIS

1 LARGE POWER SAVINGS
2 LESS WEAR
3 FAR GREATER COMFORT



VARIABLE OUTPUT FEATURE ELIMINATES FREQUENT FULL-LOAD CYCLING

with this Sturtevant Compressor-Condenser Unit

The three solenoids, shown, cut-out the individual compressor cylinders—automatically—as load decreases, eliminating frequent full-load cycling and greatly reducing stops and starts.

Also—individual compressor cylinders cut-in automatically as compressor starts. Therefore, you get a nearly-zero starting load.

As you know, frequent full load cycling—continuous starting and stopping—is a problem with ordinary compressor-condenser units. Completely eliminated is this disadvantage in the Sturtevant Compressor-Condenser Unit shown.

Because of its *variable output* feature:

1. The Sturtevant Compressor-Condenser Unit runs almost continuously. No frequent starting and stopping.
2. But, *most of the time* it operates only *at less than full load.* Variable output is controlled by a device actuated by the suction pressure of the compressor. It responds to load demands—ranging from full to no load—by cutting in and cutting out individual compressor cylinders. Under *very* light loads, for example, all cylinders are cut out but one.

   The divided evaporator permits automatic closing of a portion of the evaporator coil, when only one or two of the compressor cylinders are pumping Freon.
3. Therefore, temperature and humidity in the car remain practically fixed.

To sum up, the outstanding advantages of the Sturtevant Compressor-Condenser Unit are:

1. Large saving in horse power.
2. Less wear. Saving in maintenance.
3. Far greater comfort for passengers.

Ask our nearest office to supply full information regarding this important Sturtevant development.

Sturtevant RAIL VANE TRADE MARK UNITS OR SYSTEMS

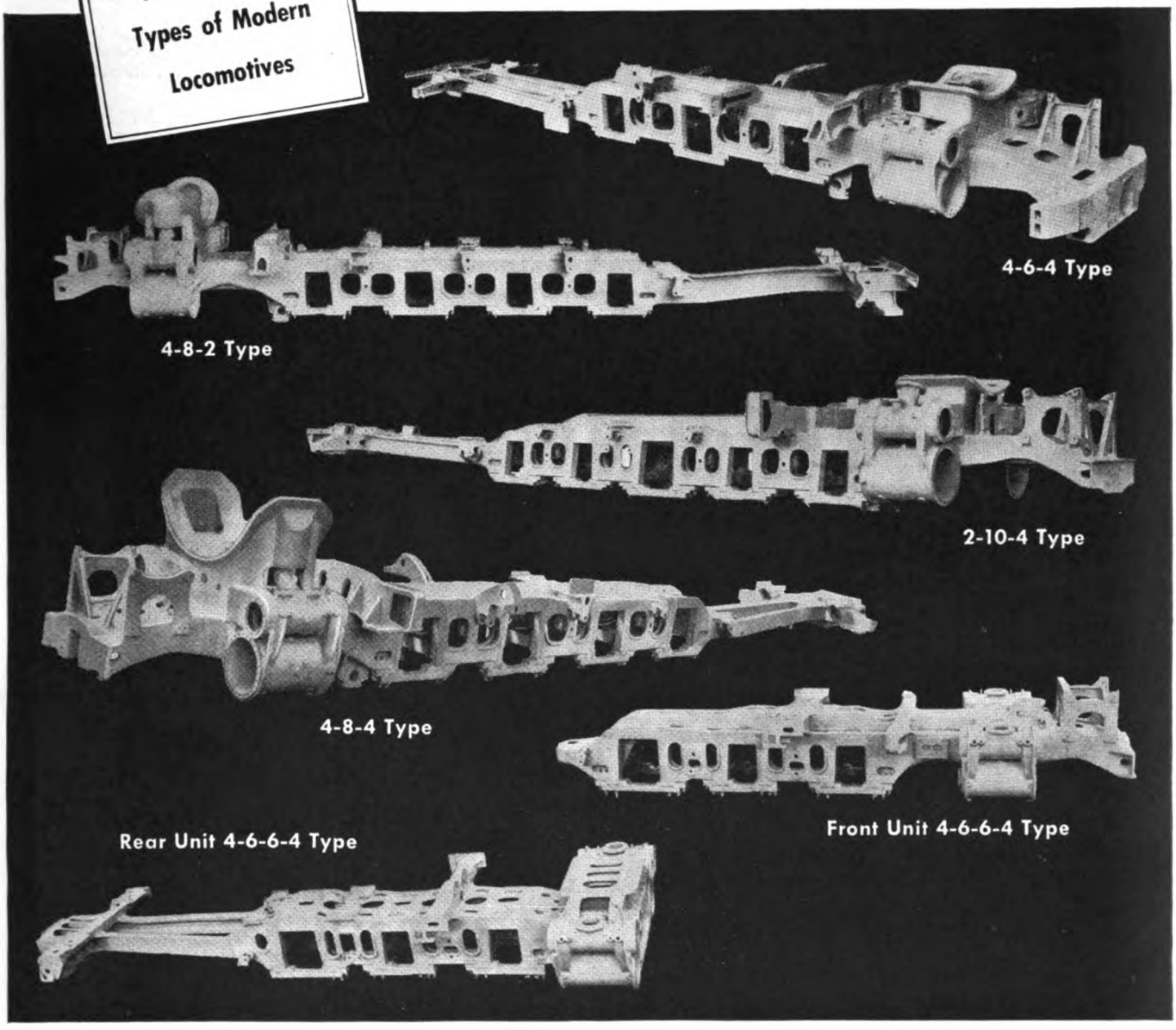
Sturtevant "Railvane" Units or Systems are used by 37 railroads. "Railvane" Air Conditioning is protected by 40 issued patents and other patents pending.

B. F. STURTEVANT COMPANY
Hyde Park, BOSTON, MASS. *Branches in 40 Cities*
B. F. Sturtevant Company of Canada, Ltd.
Galt, Toronto, Montreal

COMMONWEALTH
LOCOMOTIVE BEDS

Meet the Intensive Present Day Service Requirements of All Types of Modern Locomotives

Assure GREATER STRENGTH LOW MAINTENANCE

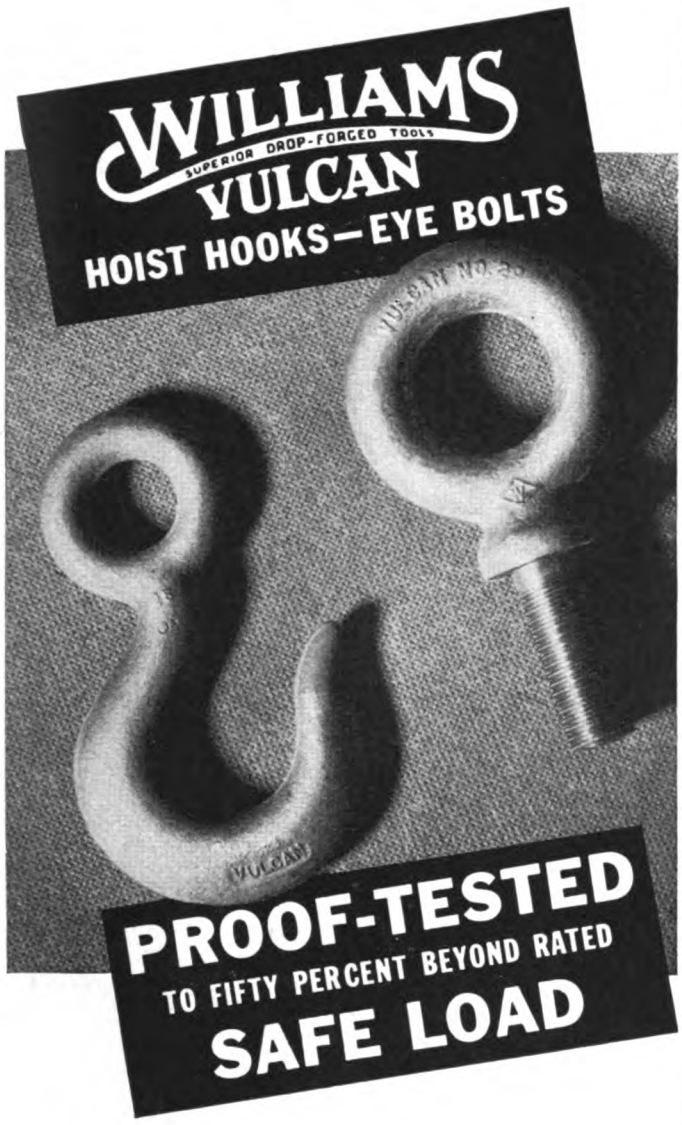


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STATEMENT of the ownership, management, circulation, etc., required by the Acts of Congress of August 24, 1912, and March 3, 1933, of *Railway Mechanical Engineer*, published monthly at Philadelphia, Pa., for October 1, 1940.

State of New York
County of New York } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Roy V. Wright, who, having been duly sworn according to law, deposes and says that he is the Editor of the *Railway Mechanical Engineer* and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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Editor, Roy V. Wright, 30 Church St., New York, N. Y.
Managing Editor, C. B. Peck, 30 Church St., New York, N. Y.
Business Manager, R. E. Thayer, 30 Church St., New York, N. Y.

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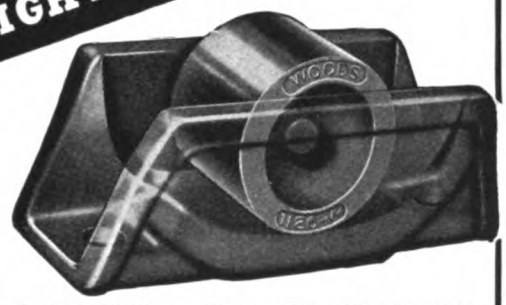
ROY V. WRIGHT.

Sworn to and subscribed before me this 30th day of September, 1940.

EDMUND J. PUYDAK.

[SEAL] (My commission expires March 30, 1941.)

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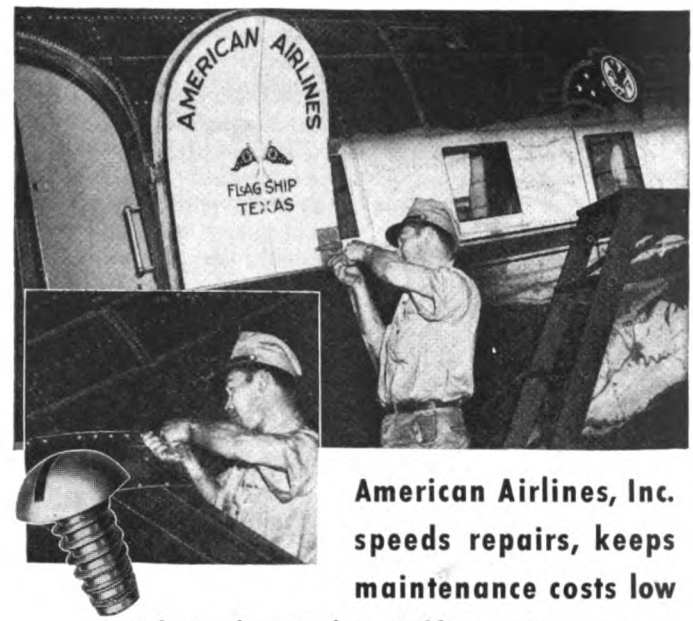
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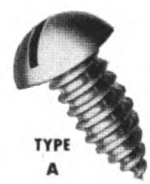


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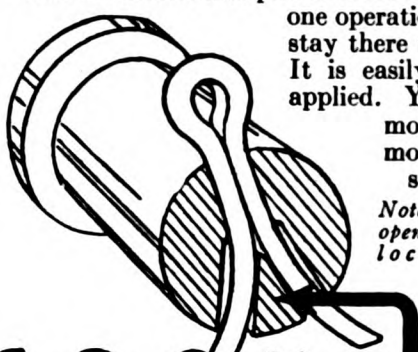
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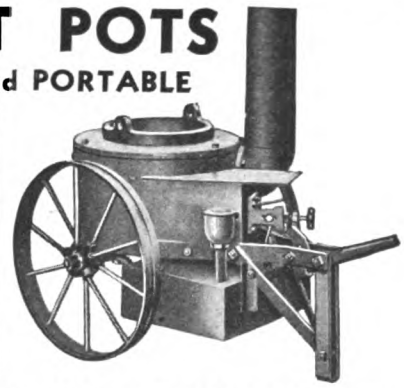
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100% RETURN in 66 days!



A CAR-RAISING AND LOWERING TEST—with manually operated jacks, four men required 30½ minutes (122 man-minutes).



WITH DUFF-NORTON ROTARY AIR MOTOR JACKS, SAME CAR, SAME LIFT—one man did the job in 20 minutes! (20 man-minutes).

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How's this for an investment . . . 100% return in 66 days! And from then on savings piled up at the rate of $350.00 per month!

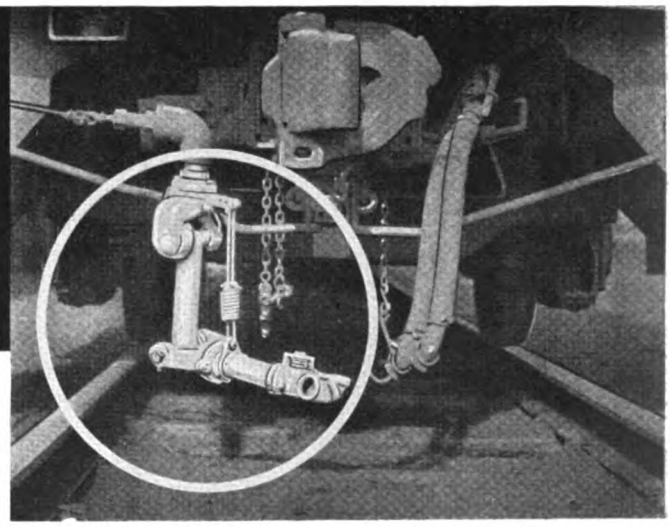
In the passenger-yard of a prominent mid-western railroad, a series of car-jacking tests was run under normal operating conditions to determine the labor cost of jacking-up and moving railroad cars using, first the customary manually operated jacks and then Duff-Norton Rotary Air Motor Jacks. When the results were tabulated, this road found that the Duff-Norton Power Jacks could save enough *in labor cost alone* to pay for themselves in 66 working days! And each month substantial profits continue to accumulate.

Write today for full data concerning the advantages of power jacking, and descriptive information about these sturdy, dependable railroad-type air motor jacks.

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(Automatically Tight)



Application Now Will Effect Big Savings

There is still plenty of time to start a program which will effect a big savings in the operating costs of this winter.

Our manufacturing facilities and reserve stocks enable us to insure immediate deliveries of AUTO-TITE FLEXIBLE BALL JOINTS for any class of service.

Applications now on your passenger cars, direct steaming systems and other steam lines, where leak-proof flexible joints are necessary, will solve annoying maintenance problems and reduce fuel consumption.

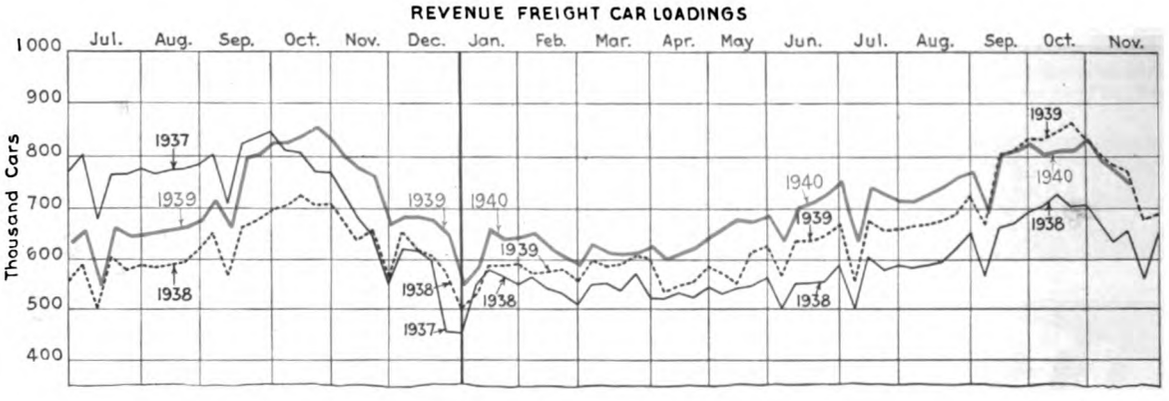
AUTO-TITE FLEXIBLE BALL JOINTS have an exclusive feature which automatically compensates for any wear and assures leak-proof performance. Why not investigate?

SUPERIOR RAILWAY PRODUCTS CORPORATION, PITTSBURGH, PA.

THE EDITOR'S DESK

USE YOUR HEAD

The freight car loadings chart indicates that for several weeks, except for the one ending October 26, business has been somewhat lighter than for the corresponding dates in 1939. It will be recalled that business picked up rapidly when Britain entered the war at the beginning of September last year. This was followed by a falling off in business during the following February and March, but the car loadings began to pick up and to grow steadily from about the middle of April.



The general belief at this time seems to be that because of the needs of Britain and our own national defense program, which is rapidly getting under way, business will hold up well during the coming months and that this will be reflected in the traffic and earnings of the railroads.

Many railway supply companies have taken on government orders for munitions and war supplies. Certain materials are already difficult to get. The railroads should see to it that their case is well presented from a priorities standpoint, where materials or equipment are essential to their continued efficient operation. Certainly, in any case, it will take much longer to secure many materials and supplies than under the conditions which existed during the 30's.

Just as one can no longer march up to a ticket window and be sure of getting Pullman accommodations at the last minute; just as it is again becoming necessary to make advance reservations at hotels in business and industrial centers; so it is also advisable to plan for and order materials and supplies well in advance, in order to assure delivery when they are needed.

There seems to be no need of becoming unduly excited, but certainly the situation requires careful planning and the very best use of available resources.

Roy V. Wright

Rx for Superior Packing Performance against Steam

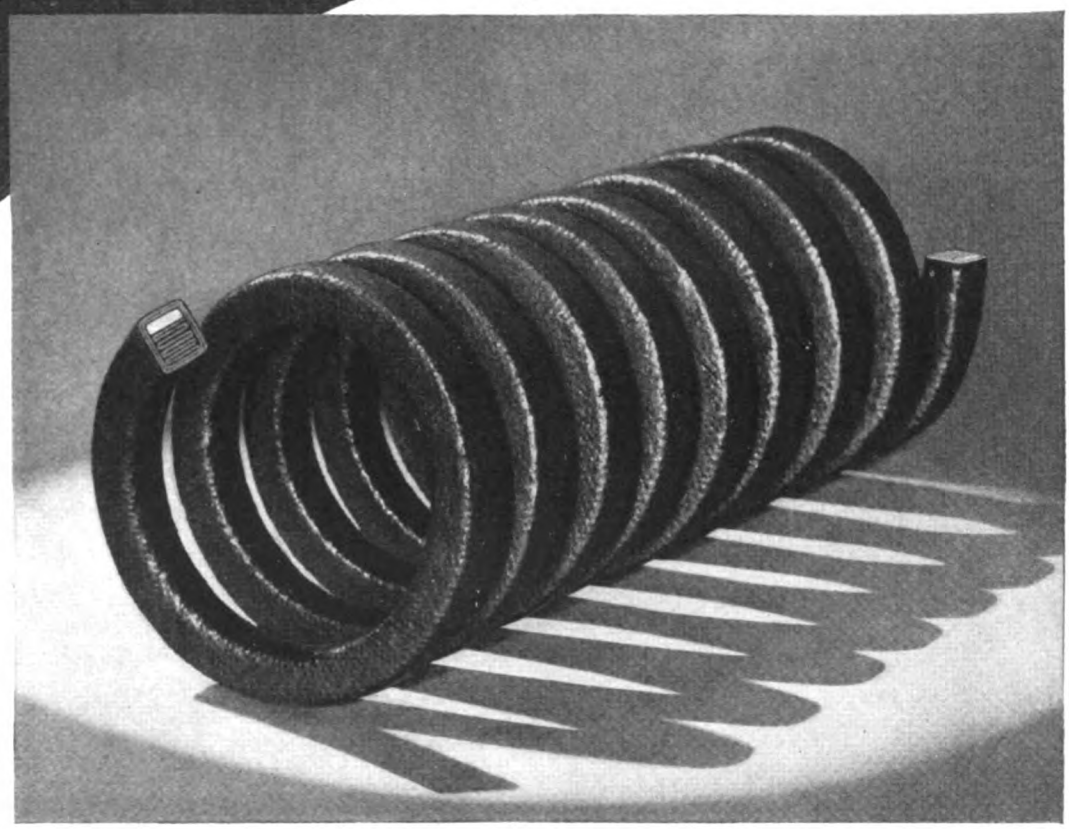


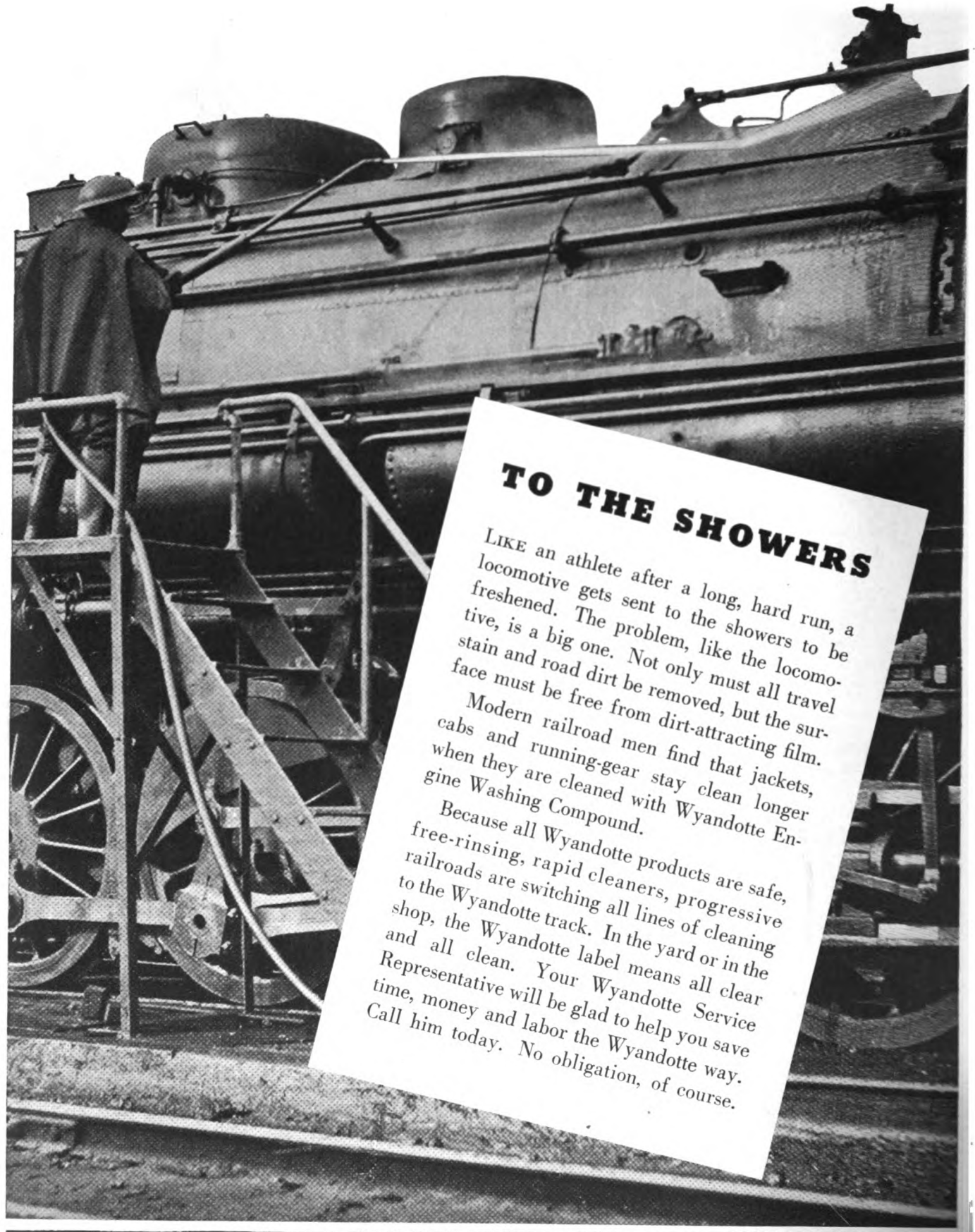
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WHY do so many thousands of engineers "prescribe" GARLOCK 150 High Pressure Packing—consistently year after year? Because they know from experience that GARLOCK 150 is *tough, strong, dependable.* They know it prevents costly shut-downs for frequent repacking. They know it saves money. For superior performance on piston rods of engines, pumps, compressors, expansion joints, etc., against steam pressures up to 300 lbs., standardize on GARLOCK 150.

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GARLOCK 150



TO THE SHOWERS

LIKE an athlete after a long, hard run, a locomotive gets sent to the showers to be freshened. The problem, like the locomotive, is a big one. Not only must all travel stain and road dirt be removed, but the surface must be free from dirt-attracting film.

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Wyandotte

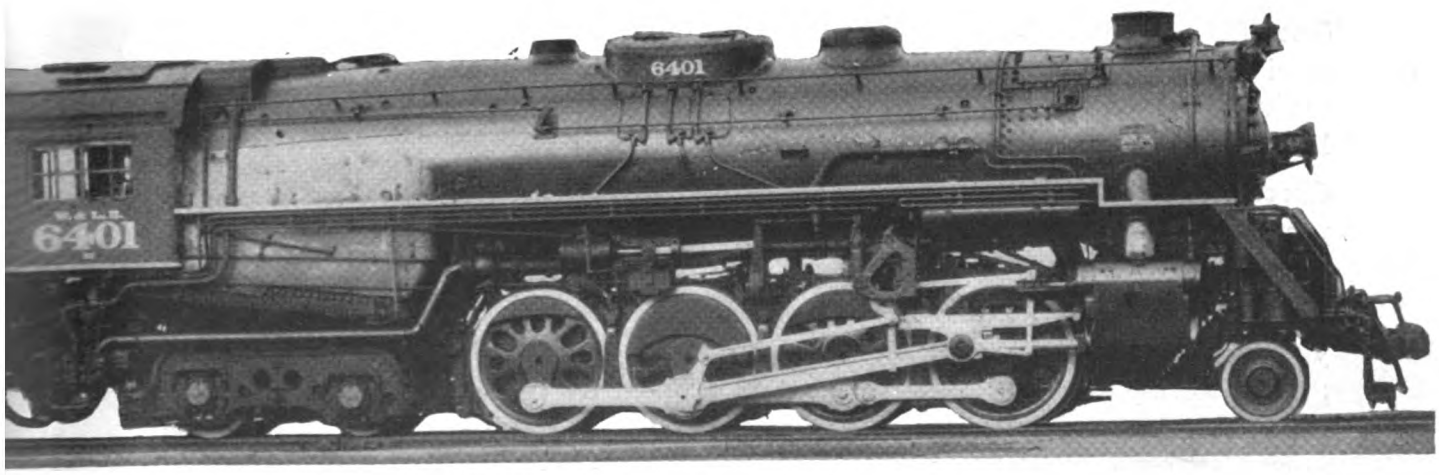
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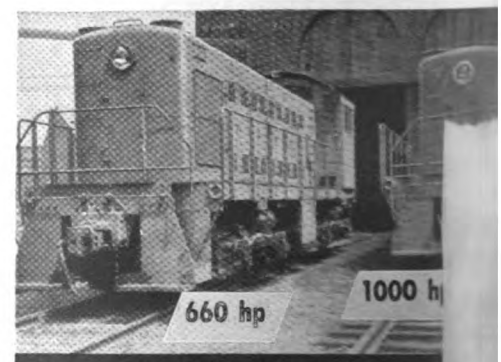
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One of these units, replacing a steam locomotive in yard switching or road freight service, will usually earn a net return of 20 to 30 per cent. This does not include savings that result if you can eliminate expensive steam-locomotive facilities.

Careful estimates show that one of these locomotives, purchased recently, will pay for itself out of savings in less than three years.

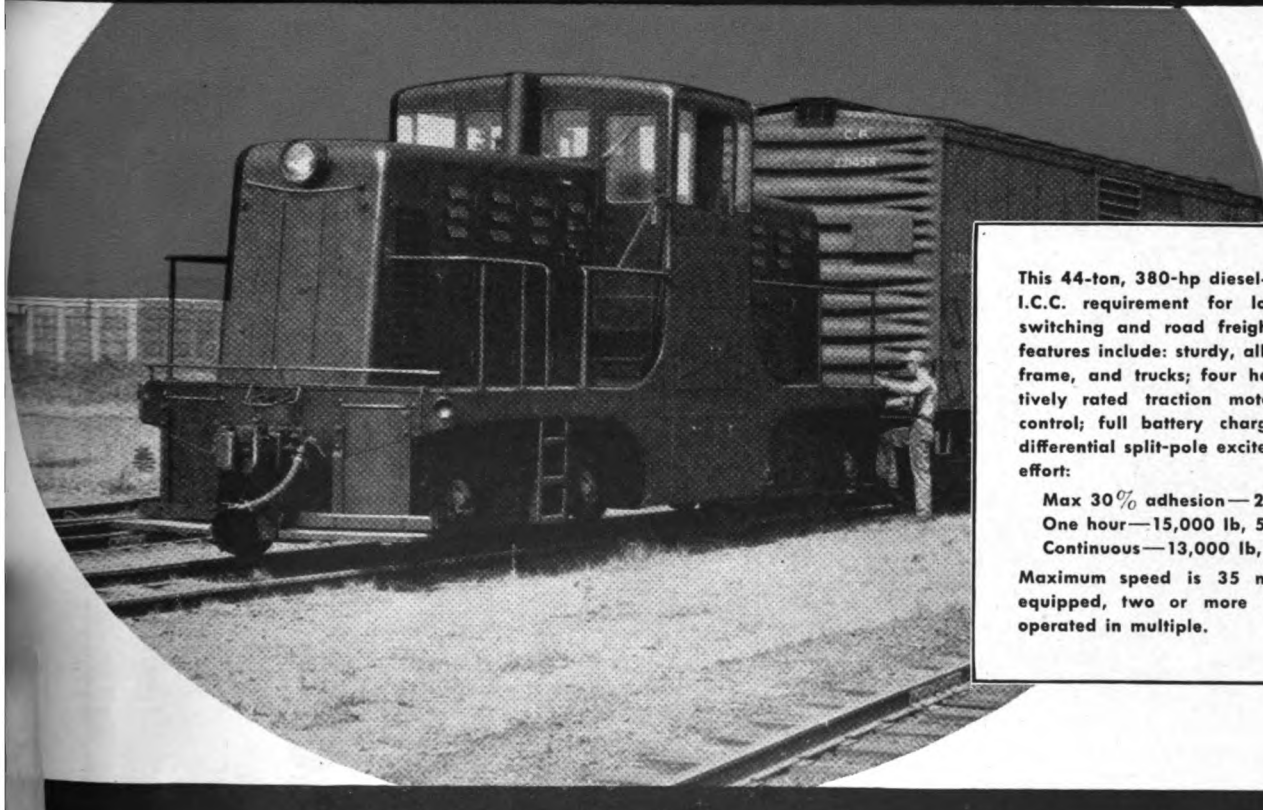
An experienced G-E transportation engineer will help you determine where these locomotives can satisfy *your* motive-power requirements most efficiently—and produce attractive savings. No obligation. Just see your G-E representative or write to General Electric, Schenectady, N. Y.



Fast, sturdy, reliable Alco-G.E. switchers will meet your requirements for heavier, more powerful locomotives.



AND ROAD FREIGHT SERVICE



This 44-ton, 380-hp diesel-electric meets every I.C.C. requirement for locomotives in yard switching and road freight service. Important features include: sturdy, all-welded cab, underframe, and trucks; four heavy-duty, conservatively rated traction motors; simple, flexible control; full battery charging at all speeds; differential split-pole exciters. Its rated tractive effort:

Max 30% adhesion — 26,400 lb
One hour — 15,000 lb, 5.9 mph
Continuous — 13,000 lb, 7.1 mph

Maximum speed is 35 mph. When suitably equipped, two or more locomotives can be operated in multiple.

GENERAL ELECTRIC

117-12



INDEX TO ADVERTISERS
DECEMBER, 1940

A

American Arch Company 36
American Brake Shoe and Foundry Co., The 8, 9
American Locomotive Company 10, 11
American Railway Products Co. 26
American Steel & Wire Company 4, 5, 6, 7
Armco Railroad Sales Co., Inc. 14
Association of Manufacturers of Chilled Car Wheels 33

B

Baldwin Locomotive Works, The 15
Bullard Company, The **2**

C

Carnegie-Illinois Steel Corp. **4, 5, 6, 7, 37**
Classified Advertisements 26
Columbia Steel Co. **4, 5, 6, 7, 37**

D

Duff-Norton Manufacturing Co., The 27

E

Editor's Desk **28**
Electro-Motive Corporation 38, 39

F

Flannery Bolt Company 40, 41
Ford Sales Co., J. B., The 30
Franklin Railway Supply Co., Inc. 35

G

Garlock Packing Co., The 29
General Electric Co. 10, 11, 42, 43
General Machinery Corp. 44
General Steel Castings 23

H

Harbison-Walker Refractories Co. 36
Homasote Co. 26

I

International Nickel Co., Inc., The 16
Iron & Steel Products, Inc. 26

J

Jones & Lamson Machine Co. 32

L

Lima Locomotive Works, Inc. 34
Lunkenheimer Co., The 45
LeBlond Machine Tool Co., R. K., The 46

M

Mahr Manufacturing Co. 26

N

National Malleable and Steel Castings Co. 12
National Tube Co. 4, 5, 6, 7, 19
Niles Tool Works Co., The 44

O

Oakite Products, Inc. 3

P

Pantasote Co., Inc., The 26
Pantasote Leather Co. 26
Parker-Kalon Corp. 25
Putnam Machine Co., The 44

R

Republic Steel Corp. 13

S

Simmons-Boardman Publishing Corp. 20
Standard Car Truck Co. 21
Statement of Ownership 25
Sturtevant Co., B. F. 22
Superior Railway Products Corp. 27

T

Tennessee Coal, Iron & Railroad Company 4, 5, 6, 7
Timken Roller Bearing Co., The 18

U

U. S. Metallic Packing Co., The 25
United States Steel Corporation Subsidiaries .. 4, 5, 6, 7, 37
United States Steel Export Co. 4, 5, 6, 7, 37

W

Westinghouse Air Brake Co. 17
Williams & Co., J. H. 24
Wine Railway Appliance Co., The ..... Front Cover
Woods & Co., Edwin S. 25

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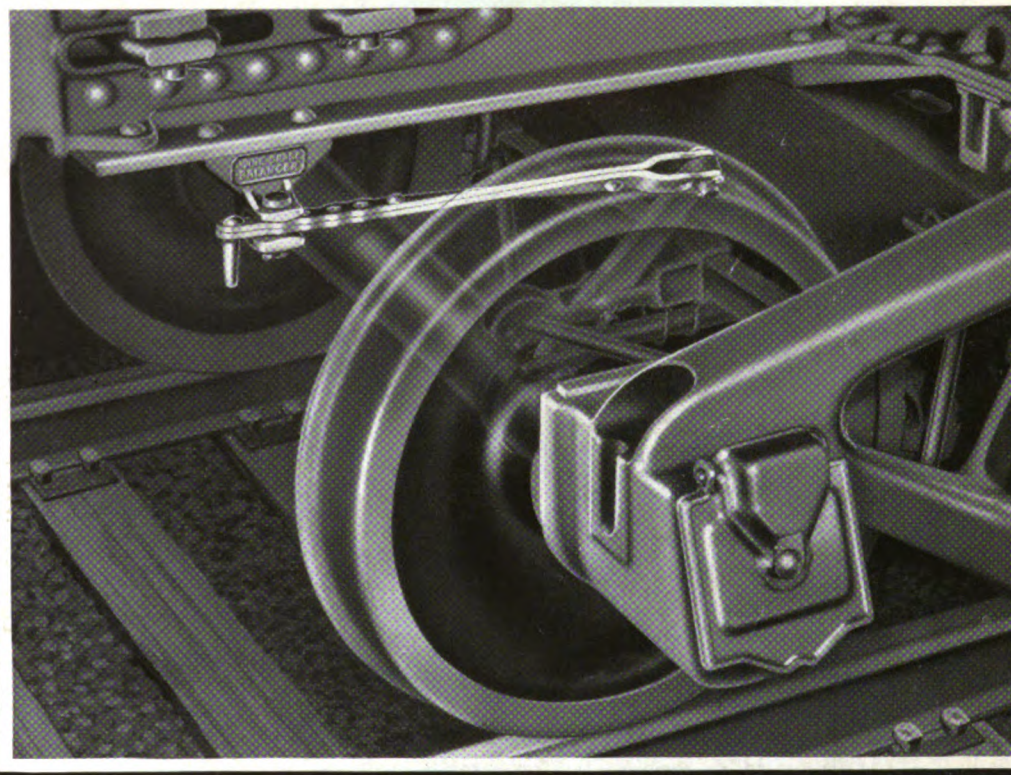
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December 1940

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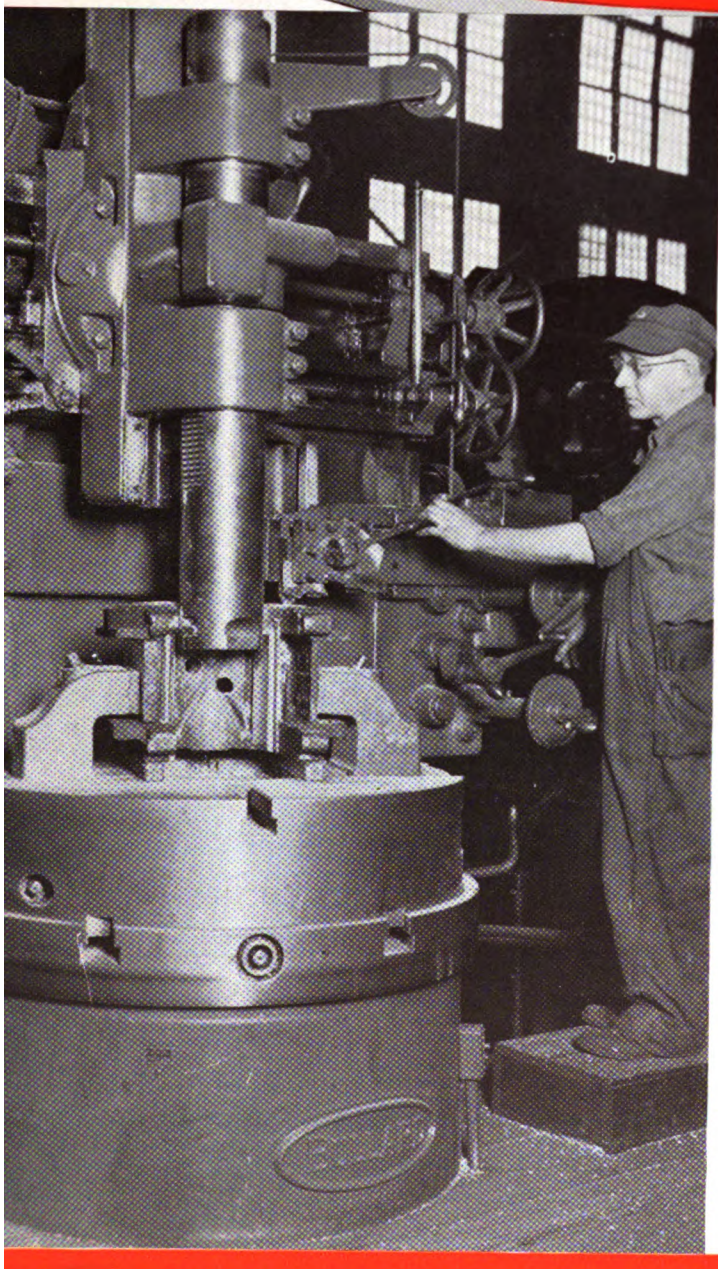
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FOR the back shops that have a sufficient amount of driving box boring jobs there is no other unit which begins to approach the production economies built into the BULLARD Driving Box Borer.

This unit is designed for driving boxes only. The extension adjustment in the main boring bar assures maximum support to the cutting tools and avoids excessive overhang.

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THE BULLARD COMPANY

BRIDGEPORT, CONNECTICUT

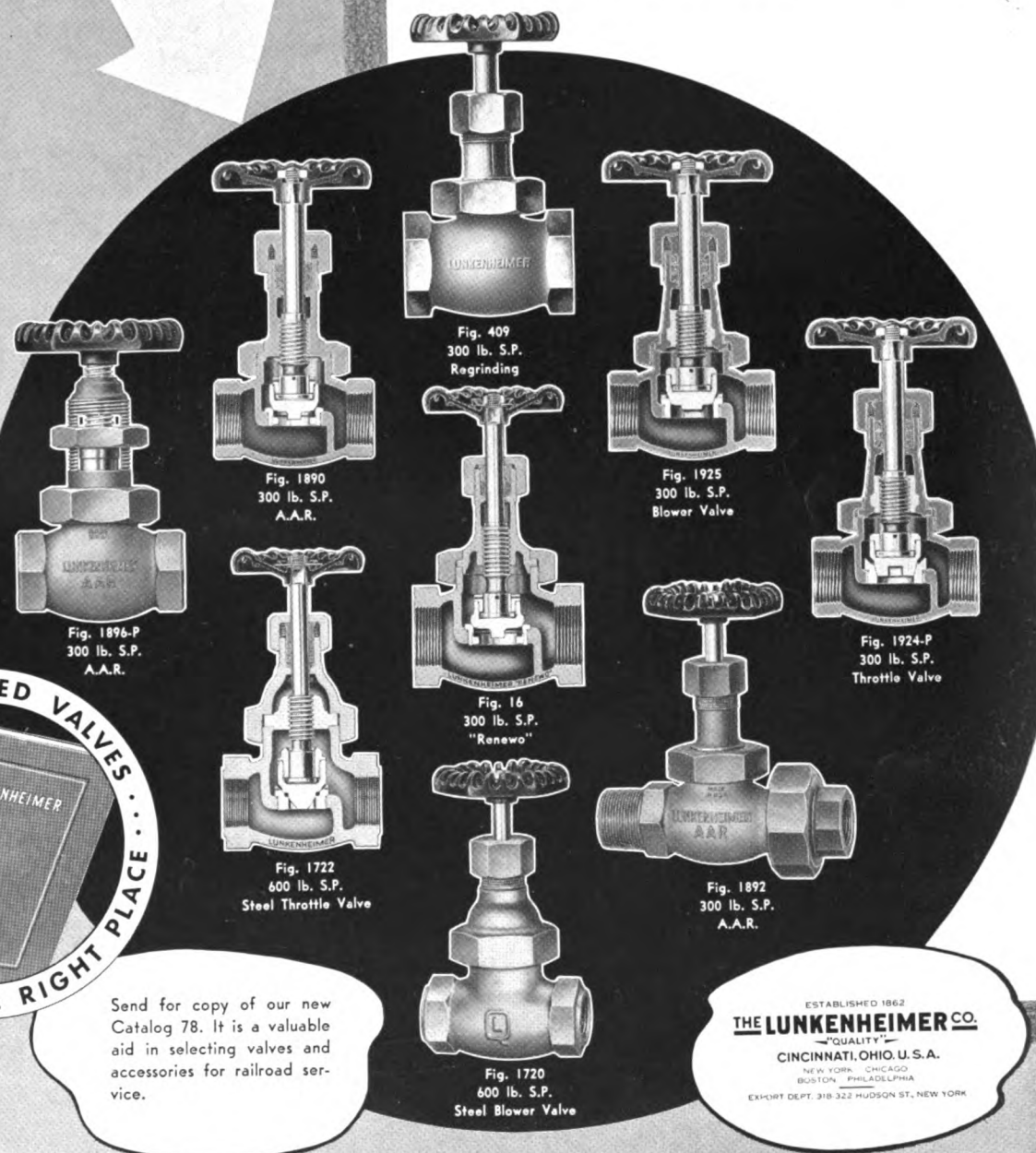
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LUNKENHEIMER offers a wide variety of valves for locomotive and roundhouse service.

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